POWER

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Thinking It Through

IN THE latter half of the Eighteenth Century there lived in Glasgow a young instrument maker.

He was a good instrument maker and was employed by the Glasgow College in the making and repairing of the apparatus in its laboratory.

One of the jobs that he was given to do was the repairing of a model of a Newcomen steam engine, numbers of which were in use at that time, mostly for pumping in the collieries.

If he had been no more than a good instrument maker, he would have made a good job of repairing the model and perhaps have taken a just pride in his artisanship—but somebody other than James Watt would stand before the world today as the author of the Age of Steam.

He not only applied his craftsmanship to the mechanical details of repairing the model, but his mind was busy with the principle and purpose, and method of operation of the engine.

He passed in review the action of the steam in the cylinder, the alternate applications of heat and cold. He saw the loss involved by the injection of the condensing water directly into the heated cylinder, and he proposed and brought into practical application those improvements and refinements that lifted the engine from a clumsy inefficient pump to a smoothly running, automatically controlled, efficient prime mover of general application.

When we say that the world owes to Watt the wonders that power has wrought for civilization, we do not mean that if Watt had not lived and thought and worked the results of his mental processes into operative machines, the industrial age would not have developed.

If Watt had not done it, somebody else would; but through his habit of analytical thought it came to pass sooner, and he looms larger as a maker of real history than the founder of any dynasty.

F. R. Low

Waste fuel burned, yet

Modern Equipment Justified

In Rebuilt Power Plant of Hudson Valley Coke and Products Corporation

THE industrial assets of Troy, N. Y., have been increased to the extent of five million dollars by the completion of the plant of the recently organized Hudson Valley Coke & Products Corporation. This establishment not only manufactures coke and its byproducts (gas, ammonia, etc.), but also operates a 450-ton-per-day blast furnace using Adirondack ore and producing pig iron for the Eastern market. The use of a blast furnace in combination with byproduct coke ovens makes possible the conversion of excess coke into a product that can be stored without deterioration. Moreover, the waste gas from the furnace is sufficient to produce all the power needed around the plant, including that required for operating the furnace.

The project was started in 1924 with the purchase of ten acres of land from the Burden Iron Works, whose present plant (for wrought-iron manufacture) lies between the coke and blast-furnace plants of the Hudson Valley Coke & Products Corporation. On the purchased plot was an old blast furnace with three hot-blast stoves, stockhouse, boiler house, and an engine room containing two old blowing engines. Much of this equipment was obsolete and all of it, with the exception of the blowing-engine house, blowing engines, one hot-blast stove and the walls of the old boiler house, was removed to make way for the new plant.

After the roof of the boiler house was raised to give added light and ventilation, complete new boiler-room equipment was installed, consisting of six boilers fired with blast-furnace gas, a sand filter and zeolite water softener, turbine-driven feed pumps, feed-water storage tank, open feed-water heater, feed-water supply and excess-pressure regulators and steel stack.

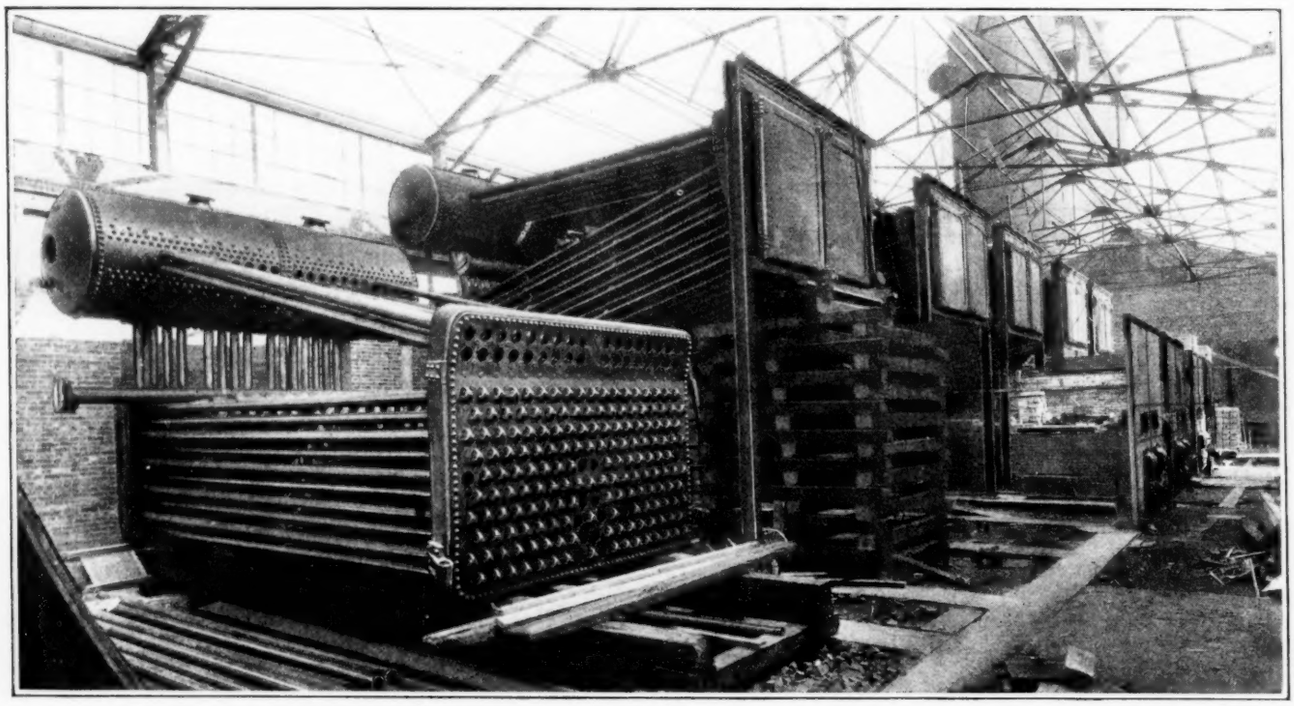


Fig. 1—View of boiler room during erection of the new boilers

The blast-furnace gas, coming to the boiler house with a heat content of 100 to 110 B.t.u. per cu.ft. and an average temperature of 700 deg. F., enters each boiler furnace through two uncooled burners set in the front wall of the Dutch oven (see Fig. 6). Air usually enters only through the spaces around the burners, although additional air may be introduced through the ashpit door as required. Since the supply of gas exceeds the plant requirements, little attention has been given to refinements as far as fuel saving alone is concerned. On the other hand, continuity of service is essential in blast-furnace operation. This consideration and the desirability of insuring the required capacity with a minimum first cost largely determined the design of the plant.

Fig. 2 (Right)—Gas mains, burners and Dutch ovens

Fig. 3 (Below)—Blast-furnace plant with engine room on right and boiler room in center foreground

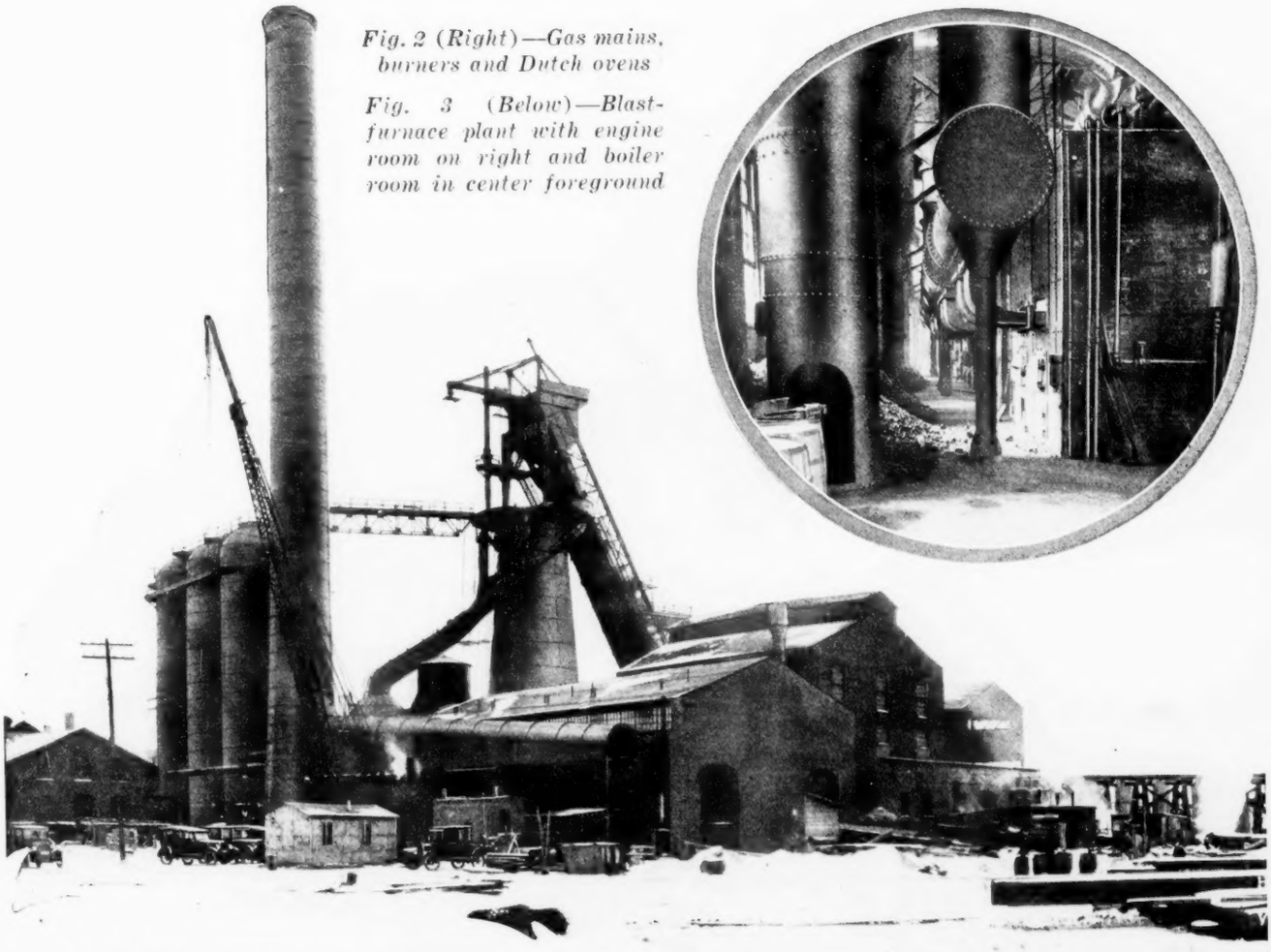


Fig. 4 (Right)—Capacity of turbo blower, just visible beyond bleeder turbine, exceeds that of two large blowing engines combined

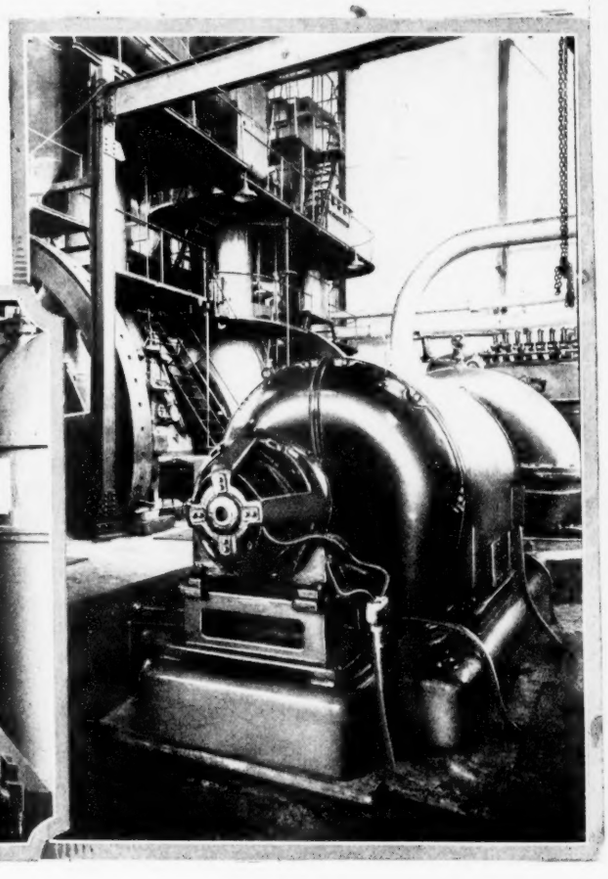
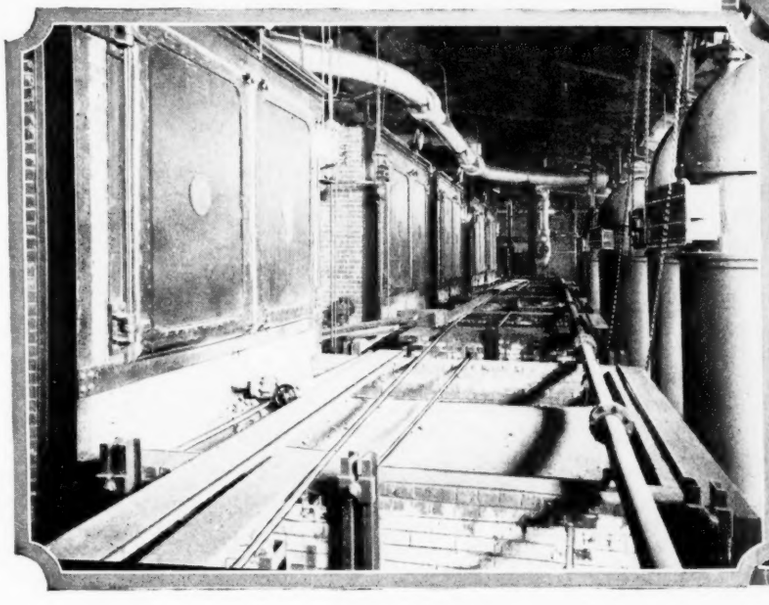


Fig. 5 (Below)—Row of boilers showing Dutch ovens and gas mains



It should be remembered in this connection that such refinements as bleeder heating and efficient generating units reduce the size and cost of the steam-generating equipment.

Dutch ovens were chosen to utilize the boiler-heating surface to the best advantage and also to assist ignition of the gas. To make ignition more certain, small coal fires are kept burning on grates in the ovens. These grates are large enough to carry the load through those occasional intervals when the gas cannot be made to burn.

The boilers are of the cross-drum, horizontal, water-tube type with 4,100 sq.ft. of heating surface each.

A striking comparison of the sizes of reciprocating and turbo blowers is furnished in the engine room. The two old Corliss-type blowers, which have been left in for stand-by use, tower thirty feet above the floor and occupy three times the floor space of the three-stage turbo-blower. Yet the latter has delivered, on test, as high as 51,000 cu.ft. of air per minute at 15 lb. pressure, and 44,000 cu.ft. at 30 lb., whereas the combined capacity of the two reciprocating blowers at 35 r.p.m. and 25 lb. pressure is only 32,000 cu.ft. per min. Each engine has one air "tub" (cylinder) of 84-in. bore. One engine has a high-pressure steam cylinder of 42-in. bore and the other an 80-in. low-pressure

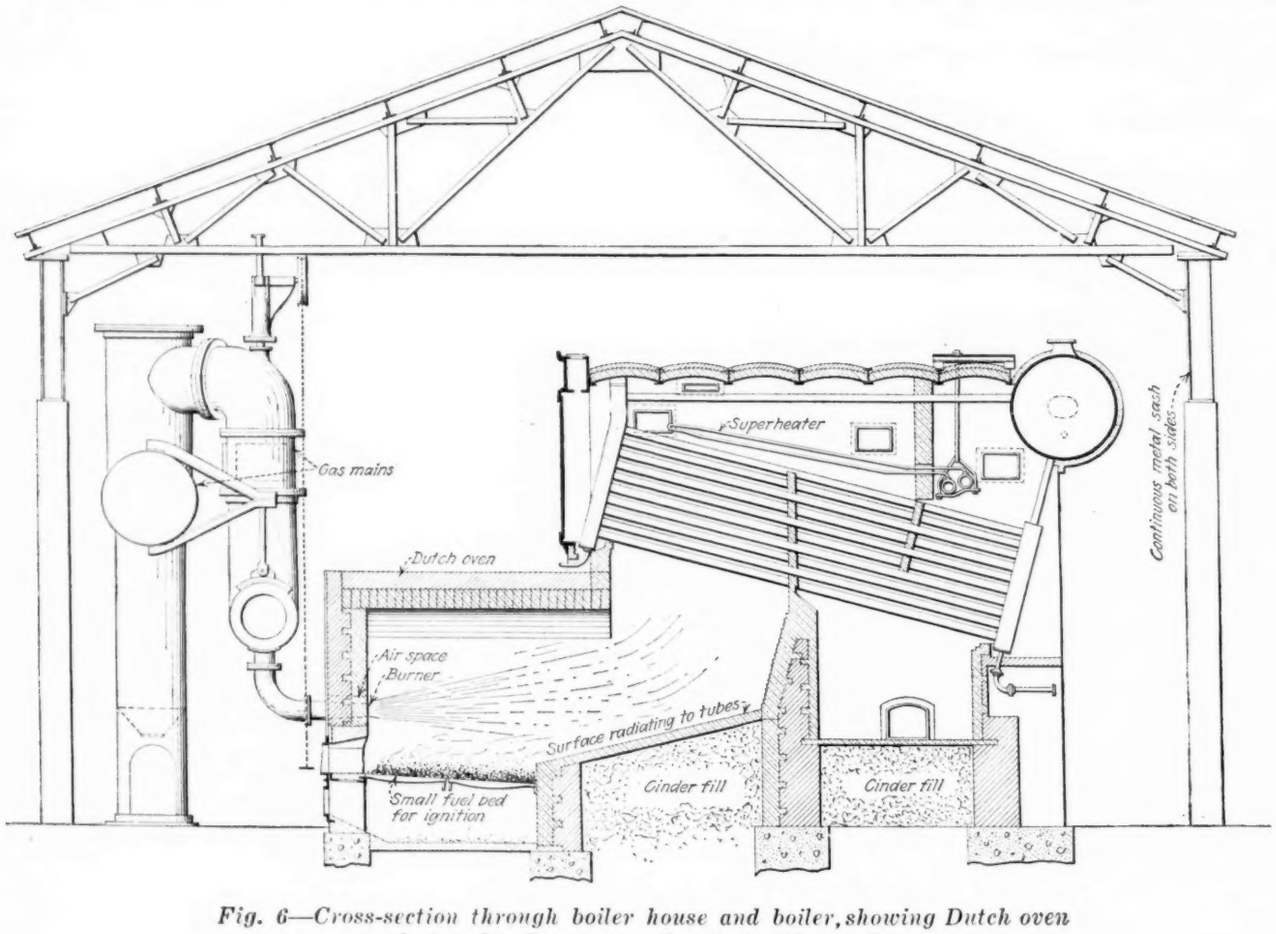


Fig. 6—Cross-section through boiler house and boiler, showing Dutch oven designed to burn gas and coal simultaneously

The lowest row of tubes is 12 ft. above the floor at the front end. Steam is generated at 190 lb. pressure and 50 deg. superheat. Each boiler is provided with vertical-type baffling arranged to pass the gases of combustion three times through the bank of tubes. The design of boilers and settings is such that every portion of the internal and external heating surface can be inspected and thoroughly cleaned.

After passing through a sand filter and zeolite softener to a storage tank mounted just under the roof, the water is heated to around 210 deg. in the open heater by bled steam and is then fed to the boiler by two turbine-driven feed pumps provided with excess-pressure regulators. Turbine-driven pumps take less steam than reciprocating pumps and thus cut down the required boiler capacity. Softened feed water insures full boiler capacity at all times and reduces maintenance.

cylinder. The stroke is 60 in. in each case. Each flywheel weighs 25 tons.

Steam for feed heating is bled at 5 lb. gage from a 1,000-kw. turbo-alternator, which generates 2,300-volt alternating current, later transformed to 250 volts for use around the plant. A tie-in with the lines of the Troy Gas Co. through an automatic throw-over switch insures a supply of power at all times for the blast furnace and coke plant.

Continuous operation is essential in the case of the byproduct coke plant as well as the blast furnace, since the former is the sole city gas supply for Troy, Albany and Schenectady.

This plant is a striking illustration of the fact that the saving of fuel is by no means the only justification for the use of high-grade equipment in boiler houses and turbine rooms.

TABLE OF PRINCIPAL EQUIPMENT IN POWER PLANT OF HUDSON VALLEY COKE & PRODUCTS COMPANY

BOILERS

Number	6
Make	E. Keeler Company
Type	Horizontal cross-drum, water-tube
Water-heating surface, each, sq.ft.	4,100
Superheaters, Elesco	Superheater Company
Safety valves	J. F. Lonergan & Co.

STACK

Type	Steel, self supporting, full lined
Builder	Riter-Conley Co.
Height, ft.	225
Inside diameter, ft., at base	14
at top	12
Breeching built by	Coatsville Boiler Works
Lining	Sil-O-Cel Concrete on sides and bottom and Sil-O-Cel C-23 brick on top

BOILER-ROOM AUXILIARIES

One pressure-type sand filter, 9x20 ft.	The Permutit Co.
One zeolite softener with two 9-ft. filters	The Permutit Co.
One duplex tank pump	Worthington Pump & Macny. Corp.

BOILER-ROOM AUXILIARIES—CONT.

One 25,000-gal. feed storage tank	Riter-Conley Co.
One 150,000-lb.-per-hr. open heater with multiport pressure regulating valve	Cochrane Corp.
Two centrifugal feed pumps, 300 gal. per min.	Worthington Pump & Mach. Corp.
Turbine drive for feed pumps	Moore Steam Turbine Corp.
Six float-operated feed-water regulators	Stets Co.
Two Mercon excess-pressure feed-water regulators	D. K. Skeen Co.

TURBINE-DRIVEN BLOWER

Make	General Electric Co.
Test capacity at 30 lb., cu.ft. per min.	44,000
Test capacity at 15 lb., cu.ft. per min.	51,000

BLEEDER TURBINE

Turbine (Kerr, bled at 5 lb. gage)	The Elliott Co.
Generator, 1,000-kw., 2,300-volt 3-ph., 60-cycle	Allis-Chalmers Mfg. Co.

Limitations of the Suess Hydraulic Turbine

By K. S. Logan

Recent reports from Europe tell of a new type of stream-flow turbine, the first of which has just been placed in operation on the Danube in Austria. Numerous efforts have been made to use some form of marine propeller to develop power from flowing water without resorting to the construction of dams or power houses. By placing the propeller or a modification of the propeller in a stream of swiftly flowing water, small amounts of power could be obtained, but the efficiency of this type of turbine was very low.

The new design of turbine, developed by Herr Edward Suess, is a radical improvement over the previous designs of stream-flow turbines and consists of a four-blade propeller similar in design to the Kaplan runner for high specific speed hydraulic turbines, but is equipped with a short conical draft tube. The unit is placed horizontally in the river, suspended below a float or barge sufficiently to submerge completely the entire apparatus. The runner, or propeller, about 54 in. in diameter, is placed at the upstream end with the draft tube flaring in a downstream direction. By this means the draft tube enlarges from a diameter of 54 in. to about 90 in. and a length of 6½ ft. The current, in flowing around the outside of this draft tube at a high velocity, creates an additional suction head and thus increases the flow through the runner.

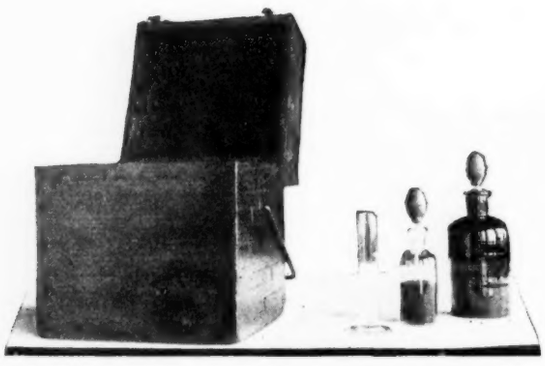
The power is transmitted to a 5-kw. direct-current generator located above water. A system of bevel gears and chain drive is used to connect the turbine with the generator. The turbine has an output of 12 to 14 hp. operating at a speed of 200 r.p.m. when the current in the river flows at a rate of 8.2 ft. per sec., or approximately 5.6 miles per hour. Using the head equivalent to this velocity, namely, 1.05 ft., the specific speed of the unit would be about 650 in the foot-pound system.

The efficiency claimed for the turbine is 74 per cent, which is probably based only on the flow through the runner itself without taking into account the quantity required to create the suction head at the exit from the draft tube. If this additional discharge were considered, the efficiency of the turbine alone would be reduced to about 50 or 60 per cent, and should the efficiency of the generator and generator drive be considered, the over-all efficiency of the entire unit is hardly more than 30 to 40 per cent.

There appears to be no means provided for regulating or maintaining constant speed, and some compensation must be made for this variable speed in the design of the generator to give a constant voltage with variable speeds. The cost of power is stated to be about 3 groschen[1] per horsepower hour based on the performance of the experimental turbine. However, with a 100 per cent load factor the output of the unit is only 43,700 kw.-hr. annually, which would increase the cost of power to 7 groschen per kilowatt-hour. However, if the ordinary lighting load factor of 30 per cent were employed, the total output throughout the year would be reduced to about 13,000 kw.-hr. and the cost of power would be approximately 23 groschen. No statement is available as to the method of calculating this cost, but it would appear on the basis of present-day costs to be in the neighborhood of 5 to 6 cents per kilowatt-hour, including the annual interest charges on the investment and a small allowance for operating and maintenance, using a 30 per cent load factor.

The application of this turbine to large powers is limited principally by practical reasons. The experimental unit develops only 12 to 14 hp. with a runner diameter of 54 in., and it would require an unusually large unit, about 15 ft. in diameter, to develop 150 hp. under conditions similar to those employed with the experimental model and the turbine speed would be reduced to 60 r.p.m., maintaining the same specific speed. The conditions under which this turbine could be applied are rare, as a current flowing at the rate of 5.6 miles an hour with sufficient depth to install a Suess turbine 15 ft. in diameter is not common in the average river.

[1] At par one groschen equals about two cents.



Two of these test kits are furnished to each watch

Maintaining Surface Condensers

By HERBERT WOTTRICH, M. E.

How a large central station tests for salinity, cleans condenser tubes and keeps trash racks free from floating débris. Special apparatus was developed to facilitate the work.

PROPER maintenance of surface condensers is a big job, and engineers are always on the lookout for ideas to aid them in such work. In one large central station considerable time and thought have been devoted to this subject, and as a result a number of successful methods and pieces of apparatus have been developed.

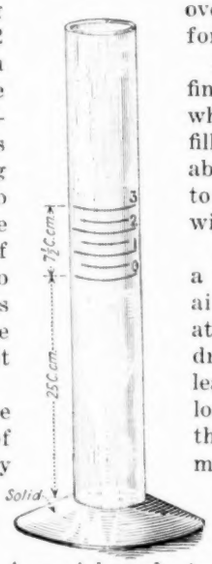
This station is of about 200,000 kva. capacity and is situated at tidewater. Therefore it is necessary to maintain tight condensers to keep out salt water. The condensing equipment is listed in Table I.

In order to know how tight the condensers are at all times, a chemical test is made on the condensate every half hour. Two test kits are furnished to each watch and are located on the condenser floor. The headpiece shows one of these kits. At the end of each watch these kits are returned to the watch engineer's office where they are placed in steel cabinets. When this system was first installed, the same kits were kept in use for the entire day. The men were careless and there was a great deal of breakage. Then separate kits were supplied for each watch and the men held responsible. Conditions then improved very much. The chemist from the Testing Department inspects the kits daily, keeping them full of chemicals and in good condition. Each test kit contains the following:

An amber glass bottle, quart size, holding silver nitrate. This solution contains 0.8202 gram of chemically pure silver nitrate which has been added to enough distilled water to make a liter of solution. The bottle has a ground-glass pipette with a rubber nipple that serves as a stopper. By pressing and then releasing the bulb, the silver nitrate is drawn up into the pipette, from which it is ejected into the graduate as described later. This method of handling the solutions, which has been put into effect only recently, makes it easier for the oilers to run the test. The old way was to pour the solutions from the bottles, and it was difficult to pour in a few drops at a time.

The small bottle in the kit is of four-ounce capacity and contains a 10 per cent solution of potassium chromate (100 grams of chemically pure potassium chromate added to enough distilled water to make a liter of solution). This bottle is also equipped with a ground-glass pipette fitted with a rubber nipple.

A small glass graduate with markings as shown is the third piece of apparatus in the kit. The strengths of the foregoing solutions are so arranged that each numbered division on the graduate represents grains per gallon of chlorine.



A special graduate is used

The determination as performed by the oilers every half hour is as follows:

A small valve has been placed in the discharge from the condensate pump, from which the sample is drawn. First, the graduate is rinsed and then is filled to the zero mark with condensate. A few drops of the potassium chromate are added by means of the pipette, which gives the sample a yellowish tinge. The silver nitrate is now added with the pipette until the color of the sample begins to turn red. The end point comes when all the sodium chloride (salt) has been used up in reacting with the silver nitrate and the excess of the latter reacts with the potassium chromate to form silver chromate, which is a red colored compound. The first permanent red tinge indicates the end point. The amount of silver nitrate added is read from the graduate. Each 2½ c.c. of silver nitrate added is equivalent to 1 grain per gallon of chlorine. Therefore the grains per gallon of chlorine in the condensate may be read directly, each number representing chlorine content.

When the chlorine in the condensate reaches two grains per gallon or over, the water is sent overboard and an immediate search is then made for the leak.

Another method is followed at this station to find condenser leaks. After every cleaning, which comes at least once a week, the shell is filled with water to a level about three feet above the tubes. If there are any leaks due to either the packing or split tubes, the water will run out at the ends of the tubes.

Still another way to look for leaks is to create a vacuum in the shell by means of one of the air pumps. The men then hold lighted candels at the end of each tube, and if the flame is drawn into the tube, that is an indication of a leak. This method is quite generally used to locate leaks around the shell of a condenser and the lower stages of the turbine while the machine is in operation.

Cleaning Tubes

Each of the six condensers is cleaned at least once a week by means of rubber plugs and air. These are placed in the ends

of the tubes and then an air hose with a rubber nozzle is placed against the end of the tube and the plug is blown through. A pressure of 60 to 80 lb. per sq.in. is employed. This work requires about six hours and the labor of six men. The cleaning is done at night, starting at ten o'clock. To clean Nos. 1 and 2 condensers it is necessary to remove the heads on one end, whereas on Nos. 3, 4, 5 and 6 it is only necessary to open the doors in the heads.

The rubber plugs are counted before and after the cleaning to determine how many were stuck in the tubes. If a plug gets stuck, it is pushed out by means of a rod, if the tube can be reached through an open

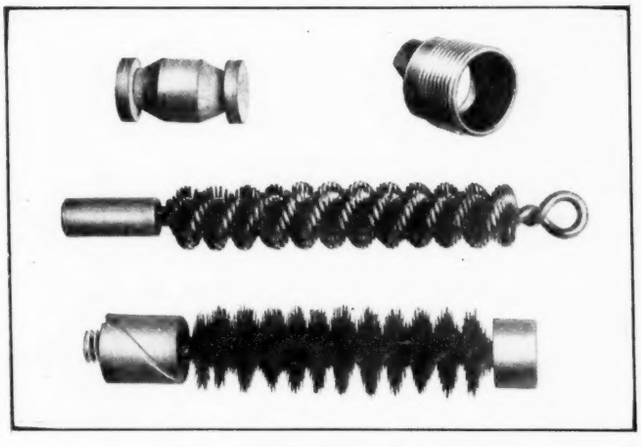
TABLE I—THE CONDENSING EQUIPMENT

Condenser	Area, Sq.Ft.	Number of Tubes	Size
1	32,000	6,434	1 in. O.D.
2	32,000	6,434	1 in. O.D.
3	45,000	9,057	1 in. O.D.
4	45,000	9,040	1 in. O.D.
5	45,000	9,040	1 in. O.D.
6	45,000	9,040	1 in. O.D.

door. If not, the tube is plugged by means of the metal plug, and at a later date, when the head is off, the plug is forced out. This metal plug is threaded to match the tapping of the ferrule in the tube sheet.

Every three months each condenser is cleaned with a steel brush of the usual type as here shown. It is attached to the end of a long rod and is pushed through the tube for its entire length. Two men are required to handle a brush, one to push the rod and the other to guide the brush to the proper tube at the start of each stroke. This cleaning requires the labor of sixteen men and takes about twelve hours. It is necessary to remove one head completely.

Owing to the construction of the second half of the station, some difficulty is encountered in cleaning condensers 4, 5 and 6 by means of the steel brushes and rods. The upper one-third of the tubes are hard to



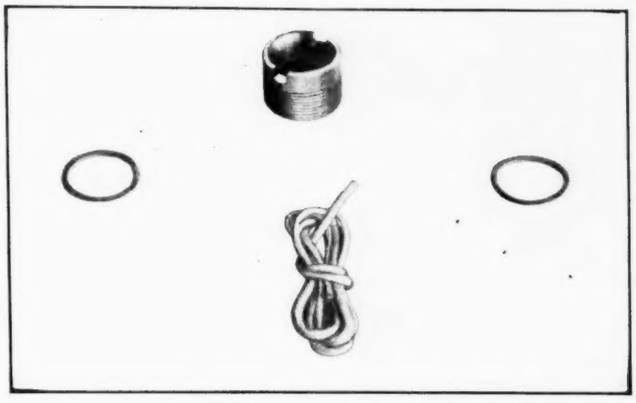
Tools used in cleaning tubes

Upper left, rubber plug; upper right, metal cap used to close leaky or plugged tube; middle, common type of steel brush; bottom, new type of steel brush.

get at because the generator air duct will not allow the rods to be pulled back their full length.

It was therefore necessary to find some other method for cleaning these tubes which would do a better job than the plain rubber plugs. To meet this need the assistant chief engineer has developed and applied for a patent on the brush shown at the bottom of the photograph. This brush consists of an expandable rubber plug attached to a brush. The rubber plug has been so designed that it can be expanded to meet the different gage tubes and differences in size of the tubes due to wear. Spiral grooves are cut along the sides of the plug, which tends to give the brush a rotating motion and also allows some water to be forced forward to flush the brush and so aid it in its scrubbing action. If it is desired, the plug without the brush may be used.

The size of the rubber plug is set for the size of the tubes in the condenser to be cleaned. The brush is



This material is used in packing the tubes

inserted first, and the brush and plug are forced through the tubes by means of water at 60 to 80 lb. per sq.in. pressure. The use of air instead of water is not recommended. This type of cleaner gives better service than the plain plug driven by air.

The sand-blast method of cleaning tubes has been tried at this station. Although producing good results, it is hard on the men. The sand is handled in a dry state and the dust from the sand along with the small particles of brass coming from the tubes, gets into the men's lungs and causes sickness. Also, this method requires over a week to complete.

After the first two years of service of a set of tubes, it is deemed advisable to clean the outside of the tubes annually. This cleaning is done by boiling. The shell of the condenser is filled with water, a steam line is run to it and live steam is blown in to heat up the water. An analysis has been made of the deposit on the outside of the tubes, and chemicals have been prepared to remove it. These chemicals are dissolved in a tank and then allowed to run into the condenser. The boiling goes on for 48 hours, after which the solution is run out and the tubes washed off with clean water.

Frequency of Cleaning and Character of Deposits

In order to keep the tubes clean, it has been found necessary to clean them as often as possible. With six machines at this station it is found practical to clean each condenser once a week. If, however, one machine is out for extensive repairs, then the one night a week that its condenser is to be cleaned, is devoted to cleaning one of the other five.

Considerable time has been spent at this station in studying the problem of clean condensers and there has been developed a method for determining the cleanliness of the tubes. This was described by Paul H. Jeynes in *Power*, Oct. 6, 1925.

As mentioned before, this is a tidewater station and is located on a navigable river which is used by the towns and cities along its banks to carry off their

sewage and waste. This is the cause for practically all of the deposit in the condenser tubes. This is of a soft slimy nature and is not difficult to remove with a stiff brush. Flushing with water is not sufficient.

An analysis was made of the river water in February, 1922. The result of this analysis is given in Table II.

In Table III are presented average temperatures of the circulating water, and steam and condensate taken by months over several years.

Packing of Tubes

All the tubes are packed at both ends with thin fiber washers and corset lacing that has been impregnated with paraffin. First a thin fiber washer, about $\frac{1}{32}$ in. thick, is pushed over the end of the tube, then the corset lacing is wrapped around the tube and pushed down onto the fiber ring. When the stuffing box is nearly full, the second washer is put on and the ferrule is then screwed in. With the tubes packed in this way, there is very little work needed to keep them tight.

TABLE II—ANALYSIS OF RIVER WATER
Twenty-four hour sample taken February, 1922

	Gr. Gal.
Silica	0.173
Calcium Carbonate	Trace
Magnesium Carbonate	3.42
Calcium Sulphate	12.60
Magnesium Sulphate	24.42
Magnesium Chloride	36.63
Sodium Chloride	338.40
Suspended Matter	0.23
Iron Oxide	Trace
Total Alkalinity	5.00
Free Carbon Dioxide	1.28
Total Solids at 100 deg. C.	423.80

An occasional tightening up is all that is necessary. When a condenser is to be retubed, an outside company is called in to do the work, as they have special tools and are experts at the work.

Special Equipment in Use

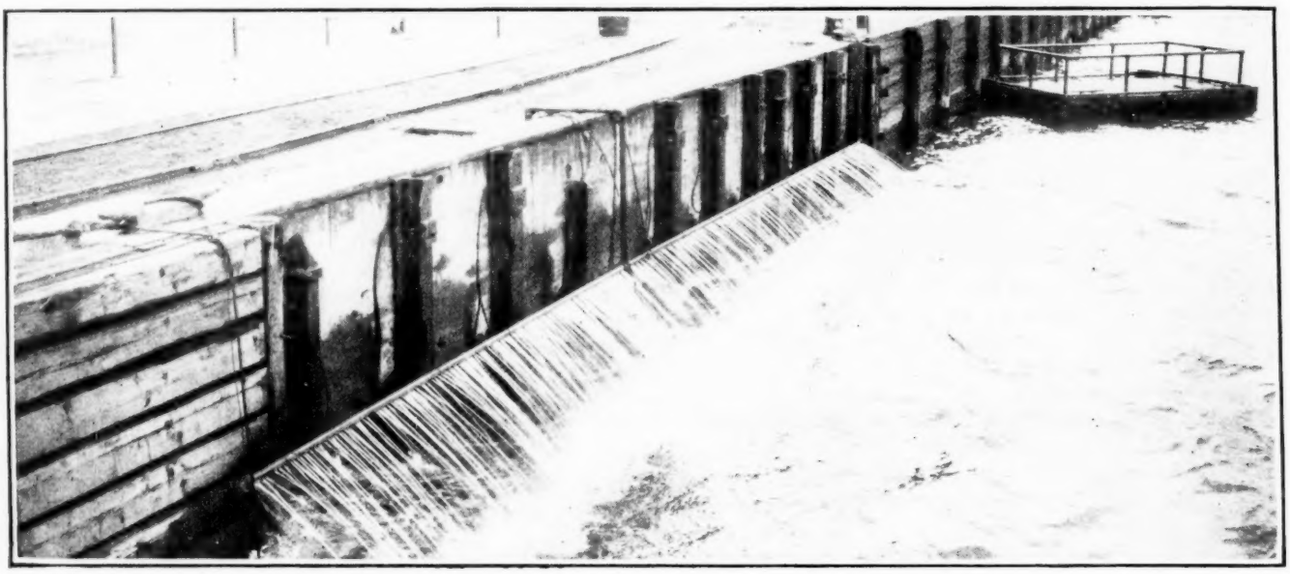
In order to facilitate the maintaining of clean condensers, there have been designed and constructed a number of useful pieces of equipment.

To clean the tubes of the condensers it is necessary for the men to be at the same height as the tubes. The old way was to construct a wooden platform each time a condenser was to be cleaned and remove it afterward. There were four steel ladders permanently fixed at each condenser across which were placed 6x6-in. beams.

TABLE III—TEMPERATURES IN DEGREES F.

Month	Circulating Water		Steam	
	Inlet	Outlet	Exhaust	Condensate
January	39.1	52.7	78.3	70.9
February	38.0	50.2	86.3	74.0
March	48.5	61.9	95.9	86.3
April	55.6	68.8	97.1	90.7
May	63.7	72.5	98.4	93.9
June	77.4	86.2	100.5	98.6
July	78.7	86.8	101.0	98.5
August	80.0	87.0	102.0	98.0
September	71.2	80.0	93.0	90.6
October	62.4	71.6	84.0	80.6
November	51.9	60.9	79.0	72.9
December	42.2	53.6	78.7	72.5

On these beams was then constructed the platform. There were two distinct disadvantages to this procedure. It required nearly two hours to put up and another two hours to remove. When the structure had been removed, the lumber had to be stored and it did not improve the appearance of the turbine room to have it lying about.



The spray keeps floating débris from entering the condenser intake

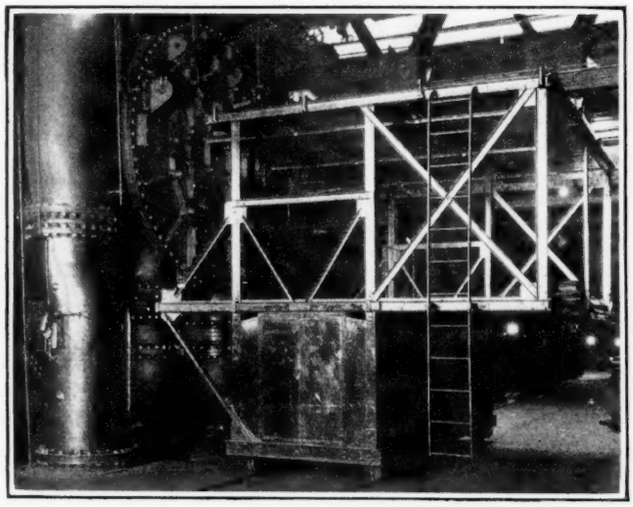
A movable platform was constructed to do away with the type of structure previously mentioned. This platform, as shown, has two levels, the lower covering the first pass and the upper making the second pass of the condenser available. It is made of steel framework with wooden platforms, and is mounted on four ball-bearing wheels, runs along the standard-gage track, and can be easily pushed to the condenser to be cleaned. The lower portion is a steel locker in which are kept the oil skins and the cleaning implements.

At this station the heads of the condensers are not all at the same distance from the track. To make them all accessible from the platforms, an extension front has been arranged for both levels. Steel rods are pulled out on each side of the platforms and planks laid across them.

For some time there was considerable trouble caused by small pieces of wood and other floating refuse clogging the trash racks. These racks are located at the bulkhead and cover the intake canals. This difficulty has been overcome by means of the salt water spray shown in the photograph. Salt water under 120 lb. per sq.in. pressure is forced through $\frac{1}{8}$-in. holes drilled in a large pipe. This spray is strong enough to keep

all floating material away from the racks. It is particularly effective in the winter time when there is a great deal of floating snow in the river which is dumped there by the cities in cleaning their streets. The spray keeps out this slush which would otherwise clog up the racks and screens.

The latest addition to the collection of equipment is a float seen in the background, which is used to clean the trash racks. The men stand on this float as the racks are raised and pull off the refuse, throwing it



This movable platform facilitates condenser cleaning

on the deck. The old way of doing this was to raise the rack and clean it on the dock, but whatever refuse fell off the rack during the lift, went down into the water and was sucked into the intake canal. The large pieces were caught by the screens, but the mud went through and got into the tubes.

The full-load current per terminal of a single-phase induction motor is determined approximately by the formula, $I = \frac{Hp. \times 1{,}000}{E}$, for a two-phase motor $I = \frac{Hp. \times 1{,}000}{E \times 2}$, and for a three-phase motor $I = \frac{Hp. \times 1{,}000}{E \times 1.732}$, where I equals the amperes per terminal, E the volts per phase and $Hp.$ the horsepower rating of the motor.

Oil deteriorates motor insulation rapidly, and care should be exercised to prevent oil from leaky bearings and external sources from reaching the windings. Failure of insulation resulting in grounds and short-circuits is more frequently traceable to inattention and neglect of proper cleaning of the unit. A machine should be subjected to a thorough cleaning once each week if possible. Windings should be blown out often with compressed air, care being taken that the pressure is not too great and that the air is free of oil and moisture.

An investigation of the performance of 4,969 current-limiting reactors in operation at voltages up to 27,600 volts by the N.E.L.A. Electrical Apparatus Committee indicated only 37 failures.

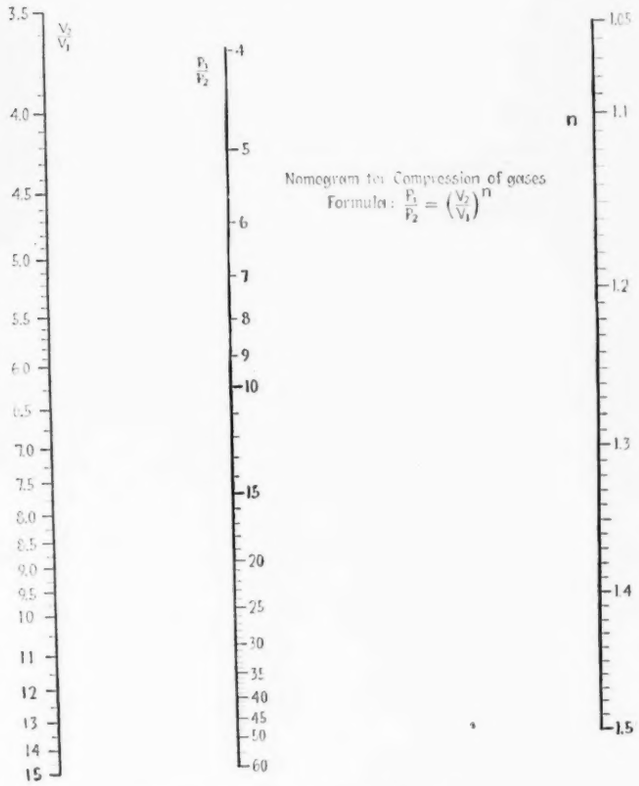
Nomogram for Compression of Gases

BY P. H. SCHWEITZER

In compressing a gas isothermally—that is, keeping the temperature constant—the pressure rises in the same proportion as the volume decreases: $\frac{p_1}{p_2} = \frac{V_2}{V_1}$. In using this formula the pressure must be expressed in absolute rather than in gage pressure. In expanding a gas the same relation exists, and with a given pressure ratio the volume ratio is at once found.

If the change is adiabatic—that is, taking place without an exchange of heat—the formula is $\frac{p_1}{p_2} = \left(\frac{V_2}{V_1}\right)^n$ in which n is 1.4 for air at atmospheric temperature.

In an engine cylinder or air compressor the compression and expansion of the gas is seldom isothermal or adiabatic and the exponent n may be almost any-

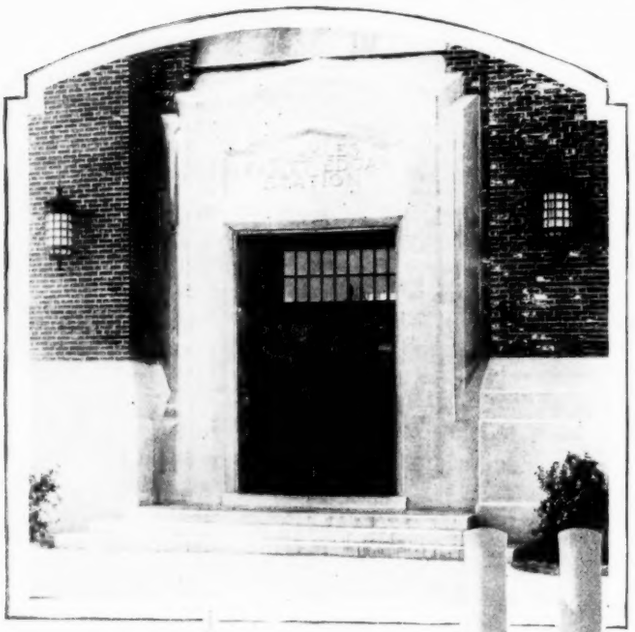


Pressure-volume relations of gases

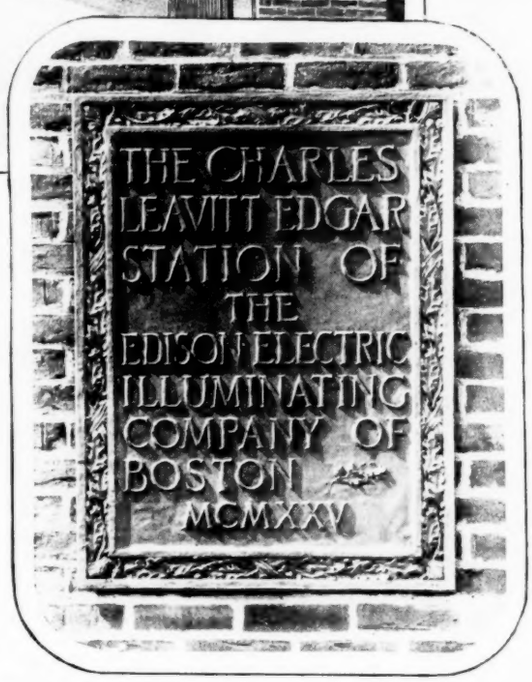
thing between 0 and 2. For the compression period in internal-combustion engines the exponent n is generally 1.3 to 1.35

The chart shown in the illustration facilitates finding the final pressure if the exponent n is known. At the same time it can be used to find the exponent n if the initial and final volumes and the corresponding pressures are known.

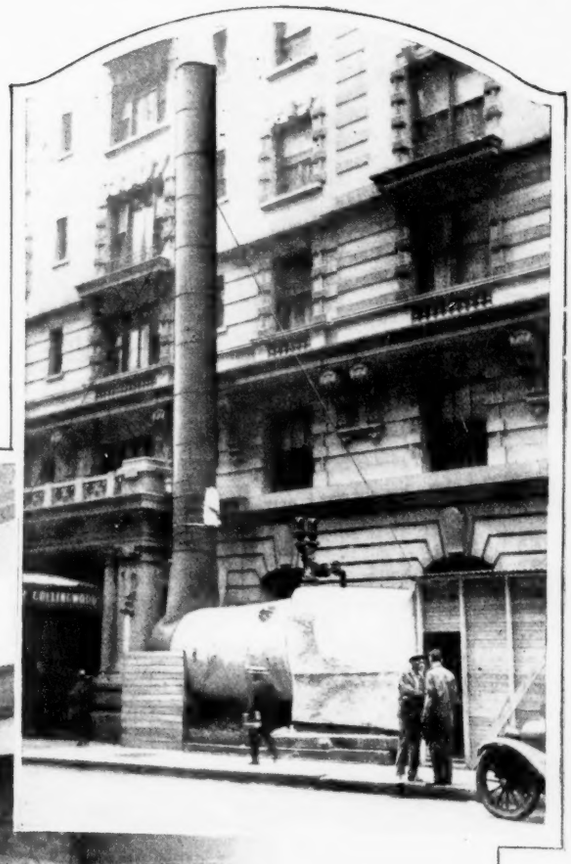
Three scales are shown: The first represents the proportion of the final volume to the initial volume; the second, the proportion of the initial pressure in pounds absolute to the final pressure; the third gives the exponent n. The procedure in any case is to mark the known points on two scales, and a straight line through these two points intersects the third scale at a point which gives the missing value in the equation.



Useful, beautiful and appropriate is this monument to Charles Leavitt Edgar, president Edison Electric Illuminating Company of Boston, under whose leadership the station at Weymouth, Mass., was built, and for whom it was recently renamed. Door, gateway and tablets commemorate this dedication to an outstanding figure in electrical development.



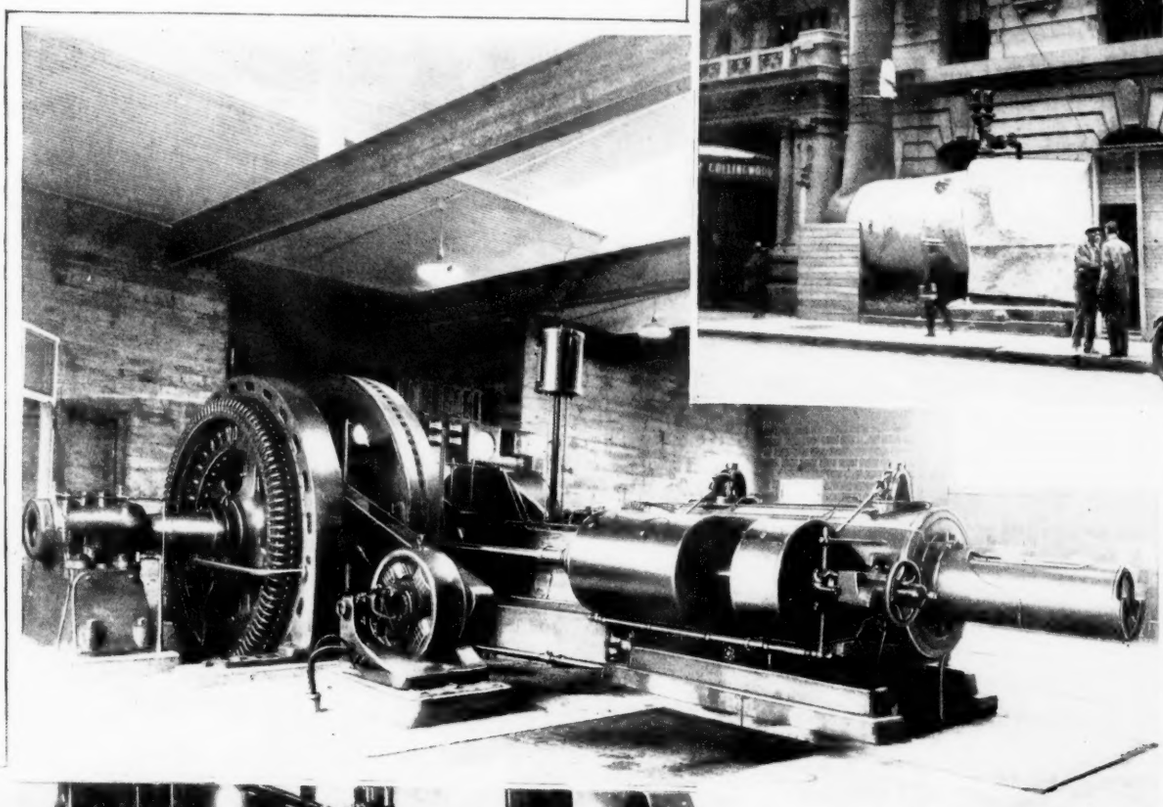
The Charles Leavitt Edgar Station is unique among American power plants because of its 1,200-lb. pressure boiler and turbine. These and other features of the station (formerly called the Weymouth station) were described in the April 14 and Sept. 15, 1925, issues of "Power."

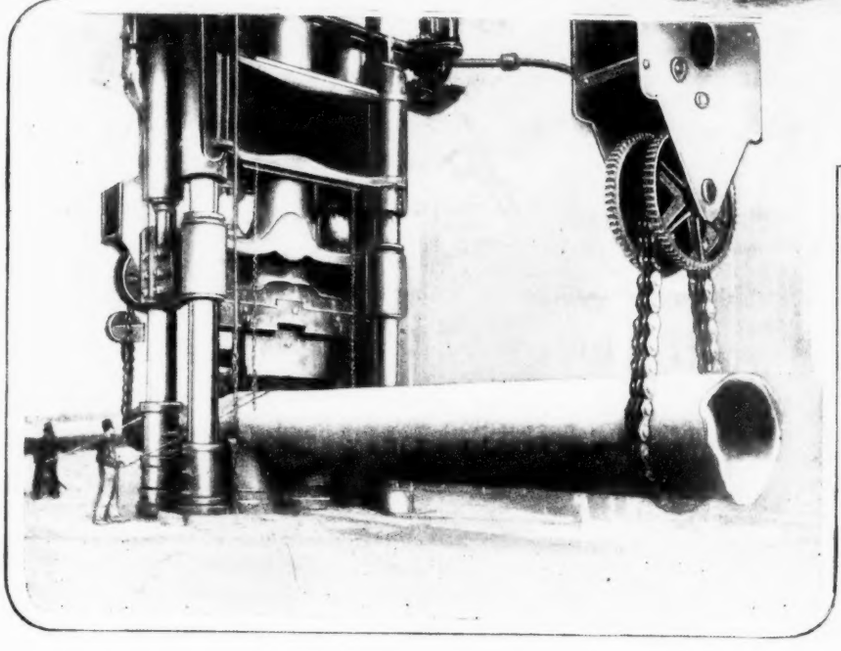


Right—This 2,000-sq. ft. locomotive-type boiler dominating the main entrance to the Hotel Collingwood, New York City, furnishes steam to run the hotel plant while two old boilers are being replaced by modern units.

Below—Five-hundred-horsepower uniflow engine recently installed at the Lake Placid Club, Lake Placid, New York.

It furnishes electricity and exhaust steam for the entire club plant, including shops, elevators and electric stoves in the 100 cottages of the Club Colony. The new water-tube boilers have been installed and equipped with underfeed stokers, economizer, air heater, forced and induced draft, CO_2 recorder, pyrometer, etc.





Left—The latest style in boiler shops.

This is the way the Germans forge seamless drums for their super-high-pressure boilers. A similar procedure was followed in forming the seamless drum of the 1,200-lb. boiler in the Edgar Station at Weymouth, Mass.

Welding in the Design of Industrial and Power Piping*

By L. J. SFORZINI
Engineering and Maintenance Department, Kodak Park, Rochester, N. Y.

FUSION welding and cutting of steel and wrought iron in the field of power and industrial piping, has recently acquired great momentum. The importance of welding in the piping field, and the sole reason for its use at all, is due to the fact that in certain specific instances its employment yields the greatest re-

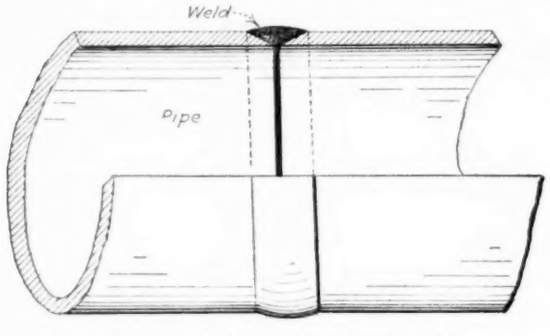


Fig. 1—V-type plain butt weld

turn per dollar invested in the piping system and in the equipment of which the piping is a part.

The author is not of the opinion that everything, or a major portion of everything, in a piping system should be welded, to the exclusion of all other methods; but he is of the opinion that every piping system should be studied by itself to determine if welding can be used to advantage.

High-Pressure Steam Piping

High-pressure steam piping includes all steam piping, whether saturated or superheated, where the internal pressure is over 50 lb. per sq.in. gage. In pressures up to about 100 lb. per sq.in. and with saturated steam, the thread joint, whether made with screw fittings with thread compound, or flange with thread compound and gaskets, is very satisfactory if properly made up, and if proper provision is made for support and expansion. Above 100 lb. pressure, with or without superheat, the threaded joint in the larger pipe sizes begins to give trouble. But the Van Stone joint, properly made up and with proper gaskets, with proper provision for support and expansion strains, gives satisfactory service up to pressures of about 300 lb. per sq.in.

Steam piping, especially high-pressure steam piping, differs from other piping in that it contains a gas at a high temperature. Provision for expansion can be made by using sleeve expansion joints, one of the various expansion bends, or by placing turns in the piping system.

Unless extreme care is used in the piping design and installation, gaskets are a source of trouble which might or might not be serious. Gasket elimination opens up an important field for welding. The elimination of flanges also cuts down radiation losses and reduces the cost of insulation.

Fig. 1 shows one of the common joints used for welding line joints. The V-type plain butt weld is the simplest and least expensive to make, and when properly made is eminently satisfactory. In making this joint the pipes are first scarfed either by machine or with the welding torch at an angle of between 30 and 45 deg. with the horizontal. The ends are then brought together within $\frac{1}{16}$ of each other, the pipe is aligned, two or more tacks are made to hold the pipe in place and the weld made, gradually working around the periphery of the pipe. This joint can be made with oxyacetylene or electric outfit. In practice it has given excellent service for low-pressure steam work, medium-pressure steam work, and in a great many instances for high-pressure steam work. But a few instances are on record where trouble has been experienced with this joint.

Reinforced Butt Weld

The butt weld reinforced with a sleeve or band (Fig. 2) overcomes the objections that some engineers have to the plain butt weld joint. This joint gives a double seal against bursting pressures, a double seal against leakage and a double insurance against tensile and compressive stresses parallel to the pipe axis. It

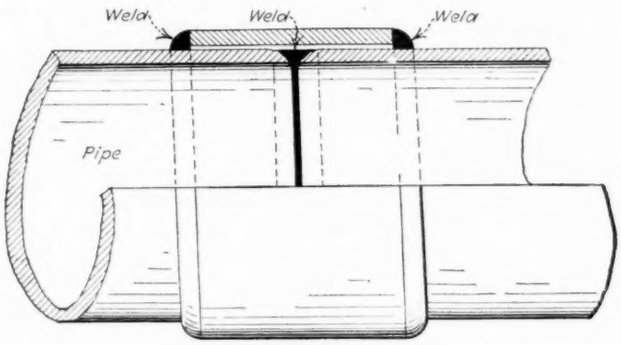


Fig. 2—Butt weld reinforced by sleeve

can be made with either the oxyacetylene or electric processes. The sleeve slipped over the butt weld is placed on the pipe before the ends are brought together and has $\frac{1}{16}$ in. to $\frac{5}{32}$ in. clearance over the pipe. Ordinary screw-thread pipe couplings are satisfactory for this work; all that is necessary is to machine the thread off in a lathe. In welding the sleeves best results are obtained by the use of two welders each on opposite ends of the sleeve; this avoids expansion strains in the weld. The writer has taken some observations in the field of the time required to make up this joint by pipe welding specialists in the employ of one of the large piping fabricators and erectors using

*Abstract of paper presented at annual meeting of American Welding Society in April.

the oxyacetylene process. The pipe is all standard full weight. The results are as follows: 6-in. pipe, 2¼ hours; 8-in. pipe, 2½ hours; 10-in. pipe, 2¾ hours; 12-in. pipe, 3 hours; 14-in. pipe, 3¼ hours; 16-in. pipe, 3½ hours.

In attaching outlets, as in line welds, the most elemental weld is the plain right-angle butt joint (see Fig. 3, upper). This weld is made by using a piece of pipe with either a screw, Van Stone, integral or other flange on one end, with the other end plain, and welding the plain end to the header at a point where a hole has previously been cut with the cutting torch. Either the oxyacetylene or electric weld may be used. The usual method is to weld on the outside after scarfing the outlet pipe; but sometimes the weld is made on the outside and also on the inside as a reinforcement. Where the outlet is small in size relative to the header, square ends are satisfactory. Where the outlets are large and closely approach the header in size, it is necessary to burn the outlet to a shape corresponding to the header contour. This can be done by the methods of simple descriptive geometry. In cutting the hole in the header, the outlet piece is used as a templet, the whole chalked or scribed off and the cutting torch used to burn the hole, making proper allowance for it. In using outlets or necks of this nature, the smaller the diameter of outlet the stronger is the resulting job. The writer prefers to use an outlet at least one pipe size smaller than the header for high-pressure work. The lower sketch in Fig. 3 shows a method of reinforcement that is sometimes used.

Low-Pressure Steam Piping

Low-pressure steam piping includes all steam piping whose internal steam pressure is under 50 lb. per sq.in., and also includes piping for steam vacuum service. This

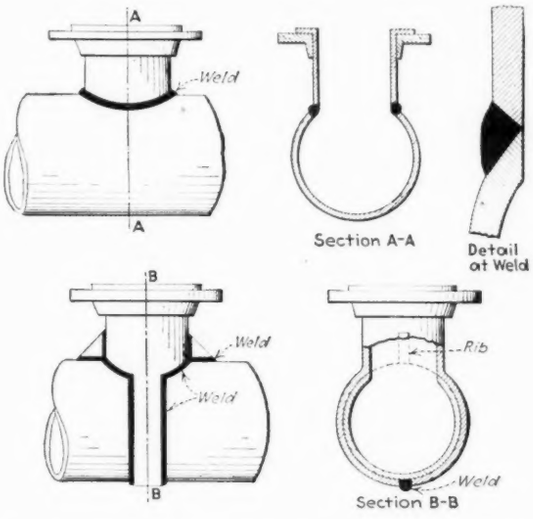


Fig. 3—Above, plain butt-weld neck; below, neck reinforced by band

class of piping presents one of the most fertile fields for welding both in pipe and fittings made from pipe. For this class and all ordinary work none of the elaborate details used for high-pressure steam service are required: First, because of less hazard; second, because the fluid pressure is less, and third, because the expansion in length is less, due to the lower steam temperature. Although the expansion is small in amount, it must, nevertheless, by no means be overlooked, but proper provision must be made to care for it. In high-pressure steam work bends are the most commonly employed for expansion allowance; in low-pressure steam work this is done by using expansion joints with the proper amount of travel or by laying out the piping system to deviate from a straight path.

In low-pressure steam piping, if the piping is fairly large in size, that is, 10 in. in diameter or over, welding

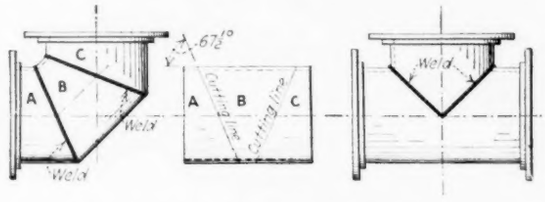


Fig. 4—Low-pressure steam fittings

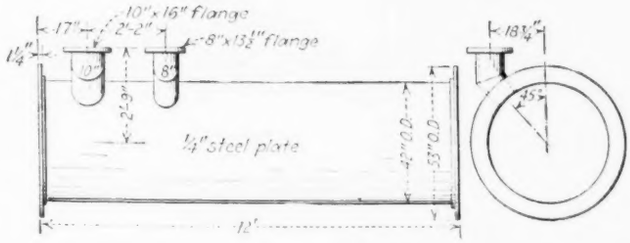


Fig. 5—Quarter-inch steel pipe, with welded cast-steel flanges and welded outlets, replaces cast-iron pipe

becomes a paying proposition, until in the larger sizes of about 18 in. or over welded pipe erected and ready for operation is so much cheaper as to make it the only method worth considering.

Low-pressure pipe and fittings made from pipe can now be purchased from fabricators specializing in this work, and of any thickness of material, depending on size and use, although ¼ in. is the most common thickness. The pipe in the larger sizes is made either from plates with both longitudinal butt welds and circumferential welds or else with lap hammer welded pipe with only circumferential welds. The lengths are usually as long as convenient for shipping. Fittings in the larger size can be procured either for standard A. S. M. E. dimensions or any practical dimensions. Special fittings to any dimensions or pipe with outlets can be purchased and present no difficulties or cause for delay. Delivery on this class of work is surprisingly quick considering the amount of special construction called for at times.

All the piping herein described can either be butt welded in the field, or flanges may be used, or a combination of both. The writer prefers the combination method because this permits welding in convenient points and bolting where it might be difficult to weld. If flanges are used, they can be procured with the ends Van Stoned; or they may be bought with loose flange, for riveting in field, and calked; or flanges can be welded in field. Another type of flange used is that made by burning out a plate to a ring form and welding the ring to the pipe, or a steel casting might be procured and welded to the pipe. A good home-made flange, if rolling equipment is available, can be made by rolling an angle iron to ring form and then welding to the pipe. An expanded sleeve may also be used for low-pressure pipe; this simplifies alignment in field before welding.

The flanges used for this work can either be drilled to the American standard for 125-lb. pressure, or to the lighter Riveted Pipe Manufacturers Standard. The latter drilling is generally satisfactory for all conditions except for bolting to a valve or fitting with the American Standard Drilling.

Fittings are so developed as to prevent waste of pipe or plate. One piece of pipe or plate is all that is required to make an elbow. The greater the number of pieces of pipe in a fitting, the greater the number of cuts made, the greater the number of welds, the greater the cost. Fig. 4 shows how an elbow can be made from three cuts in a piece of pipe; 45-deg. elbows can be made in a similar manner. The welds on a standard straight tee are also shown in Fig. 4. Reducing tees, straight or reducing crosses, side outlets or bases to suit any desire of the designer can be obtained. It is also a simple matter to weld steel lugs for support or suspension anywhere desired; this simplifies the hangers.

Fig. 6 illustrates how easily special work can be made with welding. The tapered sections were necessary because of the nature of the service. No standard fittings or any combination of them would have approximated the smooth action of the tapered fitting; had a special casting been used, delay would have resulted; the cost would have been higher.

In vacuum steam or process work, all-welded work is especially desirable to prevent all air seepage inward to the system. In this class of work it is preferable to use only such flange joints as facilitate the erection and taking apart of the system in the event of repairs. Welded flanges should be used in this connection because once made tight they always remain tight.

Refrigeration Piping

Ammonia piping may be under two different pressures. All piping from the ammonia expansion valve to the suction shutoff valve of the compressor, is known as low-pressure piping, and is normally under a

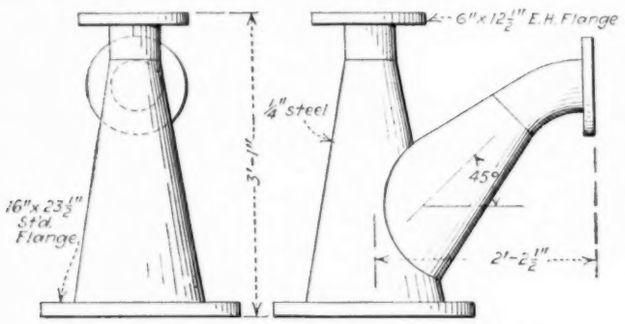


Fig. 6—Special fitting made by welding

relatively low pressure or under a vacuum. Certain factors in operation can sometimes place this side of the system under high pressure. It should, accordingly, be designed from the strength viewpoint exactly the same as for the high-pressure side. The piping on the low-pressure side except the cooling coils is almost without exception always covered with cork or other appropriate insulation. This factor of insulation is highly important from the welding standpoint, as will be shown presently.

All piping from the ammonia compressor discharge back to the expansion valve (except piping to and from the intermediate cooler if the system is compound), is under condenser pressure, and is known as high-pressure piping and is invariably uninsulated. The upper limit of this pressure is fixed solely by the temperature and quantity of cooling water available for the condensers, and the quantity of inert gas in the piping system; 300 lb. to 350 lb. per sq.in. is the pressure always designed for in the Northern States. The pressure is kept below the designed maximum by the use of suitable ammonia relief valves. Ammonia is too valuable a fluid to discharge to atmosphere or to a sewer, and all precautions are taken to make it remain in the system, except where danger to life and property is involved by the retention.

The chief use of welding in ammonia piping is for

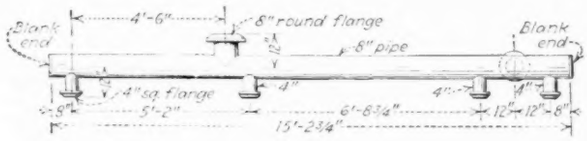


Fig. 7—Ammonia header used to save time and cost of insulation

welding nipples, pipe couplings and blank ends on headers, and pipe outlets, etc., on pressure vessels. Welding in headers eliminates flanges and gives great compactness. The outlets are usually made of pipe material standard or extra heavy and using either the pipe itself or couplings. The flanges on outlets when used are always of the tongue and groove, or male and female type.

Ammonia pipe flanges are invariably screwed on, using a thread compound such as litharge and glycerin, or the flanges are tinned and sweated on. Pipe with this type of flange when installed and left in service a number of years and then taken apart, should be tested for thread leaks before being reinstalled, or some of the work will have to be done over again. It is most economical and time-saving to burn off the ends of the pipe, and then to rethread or weld the ends of the pipe together.

Fig. 7 is from a design by the writer used on an alteration job when there were not enough standard fittings available for the job and time too short to await shipment of the standard fittings, and the making of a special fitting. This header was used as a low-pressure header, and a neat saving was effected in insulation costs as well as in the piping itself.

Brine Piping

The gaskets on brine systems, if of the proper type and properly installed, are rarely a source of trouble. In spite of this, however, welding has a rich field in brine piping. All pipe flanges on brine-carrying lines must be insulated. First, because of the economy obtained; second, because were the flanges left bare, they would frost up and be a starting point for rotting a greater proportion of the adjacent covering. Everything considered, a handsome saving can be effected by the use of a brine header. In both the brine system and the low-pressure refrigeration system the ordinary expansion is negative, that is, a contraction and comparatively small in value, but, nevertheless, provision must be made to care for this.

Air piping can be classified as either high- or low-pressure. High-pressure air is discharged from an air

compressor; low-pressure air is discharged from a fan. High-pressure lines as a rule do not attain large size, and screwed fittings are satisfactory for most work. In special cases, such as long lines, special fittings, etc., any of the welds described for high and low pressure steam may be used.

Low-pressure air is handled usually in large volume and for ordinary work galvanized iron and soldered joints are satisfactory. However, for pressures slightly above that common in ventilating work, say 4 in. of water pressure or over, and where thickness of metal must be comparatively heavy to provide for corrosion, welded ducts can be used to advantage. The writer employed all-welded air ducts to good advantage in remodeling the air supply to a stoker system recently, where the material used was ¼-in. plate made into 30 in. diameter and scrap pieces of standard pipe from 16 in. diameter down to 8 in. Flanges on the ends of the pipe to take removable blanks were cheaply made by welding a square plate with hole to the pipes.

Water Piping

As a rule for above-ground water piping in the smaller sizes screw fittings are satisfactory, and for cold-water work in the large size galvanized spiral riveted pipe is satisfactory for all ordinary work. The cost of such material ready for erection is usually so low that welding does not, as a rule, pay. But, for large fittings, special fittings, outlets, etc., welding is very economical.

Making Tests

In designing a piping system a factor of safety of at least six is used, and this factor should also be used in welded work.

For high-pressure steam work the test usually applied is hydraulic pressure two to three times the maximum working expected pressure, pounding the joints with a hammer while under test pressure. If any defects exist in the welds, they are indicated by small leaks or sweating. Some engineers require the cutting out and remaking of all joints that sweat under pressure and rewelding; others merely require reworking the metal in the vicinity of the defect with the torch. The writer deems the latter method satisfactory, for experience indicates that once a welded line is made tight under water pressure and impact, it will never leak steam. After the foregoing test it is usual to make a temperature test by feeding steam very gradually into the line till the full working pressure is built up. This test is made before covering the line.

For very low pressure steam lines a satisfactory test is made with 50 lb. hydraulic pressure, but without impact, if supports permit the weight of the water. Air at this pressure may be used, but is generally more laborious. Sometimes for very low pressure the test is omitted entirely, but never in vacuum work. Steam is turned on gradually; if no leaks develop when up to pressure, the line is ready for operation.

Ammonia lines in the field are tested to 300 lb. or 250 lb. air and soap bubbles, and in the shop are tested to this air pressure under water. In the high-pressure side of the system the impact test should always be used in conjunction with the air test.

Brine piping is tested with hydraulic pressure equal to twice the working pressure and impact. Air piping should be tested with air and bubbles if on a compressor discharge. No test is required for air piping used in fan work. Water piping is tested the same as brine piping. General fluid piping is tested as conditions warrant.

Materials and Workmanship

In all installations with which the writer is personally acquainted, the material used for pressures up to 350 lb. is standard full-weight pipe, except when very small nipples or outlets are used; then extra heavy is sometimes necessary for increased thickness required to make a good weld. No special pipe was ever used; the pipe was commercial, taken from ordinary pipe stock bought to ordinary specifications from a reputable mill. No preference is ever made as to open-hearth or bessemer steel, although some welders prefer the open-hearth. In all welded joints made, both electric and oxyacetylene, the author has come in contact with in piping and unfired pressure vessels, not one has ever shown a defect after proper tests were made.

Welded joints have been scrutinized for defects and each defect magnified. But in a certain measure this close observance is beneficial, for it has taught caution in a comparatively new art. The fact that welded piping is now in such extensive use, and its use increasing day by day, indicates that criticism has not been in vain. This precaution must not be so stringent as to throttle welding, but must be rigid enough to secure against failure. The best precaution possible is to use only welders and welded material of known reliability; that is, deal only with fabricators and welders who value their reputation.

The piping designer should co-operate with the maker of welded material; he should properly allow for all stresses, expansion, pressure or otherwise. Welding is a most important tool to the piping designer, and he should understand both its possibilities and its limitations.

Turbine Designed for Conversion to High Pressure

A 6,000-kw. steam turbine, designed for use initially with steam at 165 lb. per sq.in. and 100 deg. F. superheat, with provision for easy rebuilding to operate on steam at 350 lb. and 700 deg. F., is to be installed by the Trinidad Electric Transmission, Railway & Gas Co., of Trinidad, Colo., which supplies power to southern Colorada coal mines. The Walsenburg Station, where this turbine is to operate, is an old plant with low pressure and superheat, but the company plans to install new boilers, bringing the steam pressure and temperature to higher levels. Provision will be made for steam extraction from two stages for feed-water heating.

The turbine has been designed by the General Electric Co. with all high-pressure parts suitable for the maximum steam temperature and pressure, and the casings and shafts are designed for 14 stages, but for the initial low-pressure operation only 9 wheels will be installed, and the first-stage nozzles and buckets will be suitable for the lower pressure. The five additional wheels, together with high-pressure nozzles, will be shipped with the turbine, so that when the plant is rebuilt these parts can be installed without delay.

In this way the company will secure the benefits of maximum economy under both present and future steam conditions.

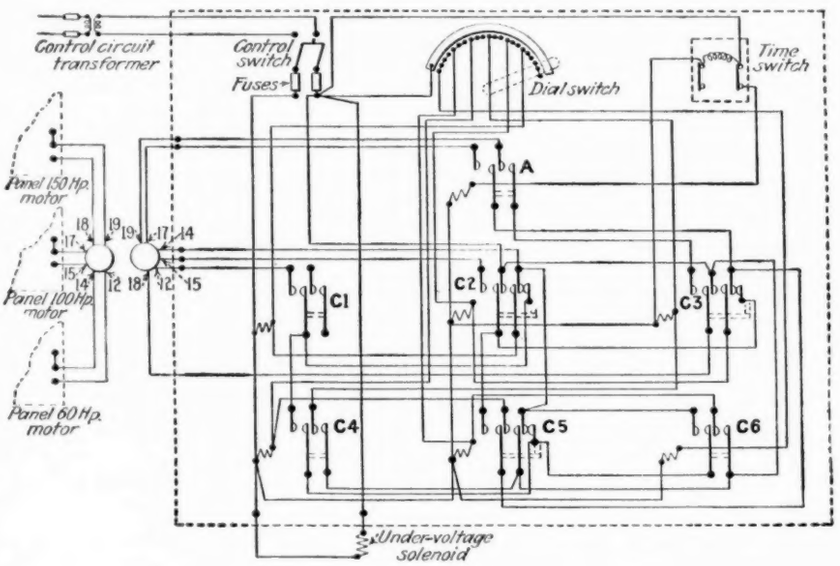
Control Operates Three Pumps in Six Combinations

By A. F. BOWERS
Industrial Control Engineering Department, General Electric Company

AN INTERESTING system of pump-motor control, shown in the figure, was recently devised for controlling an installation of three squirrel-cage pump motors used to maintain the water level in a reservoir. It was desired that standard automatic-starting compensators be used, with an auxiliary control that would give six combinations of the pump motors at six different levels of the water in the reservoirs. It was further desired that but one of the pumps operate during certain periods of time, the other two automatically shutting down to start again only at the end of the shutdown period.

In view of the fact that ice would foul the mechanism of a float switch during the winter months, it was decided to use an automatic regulator panel having six control points, each point to represent a definite level of the water in the reservoir.

There were mounted on the panel the regulator, a dial switch, a control-circuit switch, a time switch and seven double-pole control relaying contactors. Rather than make up a new dial switch with six points, a field control switch with 21 buttons was utilized, the six points being obtained by wiring the 21 buttons into seven groups of three buttons each, as shown in the figure. The undervoltage solenoid at the bottom of the diagram is used to bring the arm of the dial switch to the off position in the event of power failure.



Wiring diagram of sequence control panel for three pump motors

It was desired that only the 60-hp. motor operate during certain periods of time. This was accomplished by a time switch and control relay *A*. The normally closed tips of the time switch were wired in the coil circuit of contactor *A* and the control circuits of the starting panels for the 100- and 150-hp. motor were wired through this contactor. During normal operation contactor *A* is closed and all the motors start on their respective points of the dial switch. However, during the period of shutdown the tips of the time switch open and contactor *A* drops out. During this time only the 60-hp. motors will operate regardless of the position of the dial switch.

In operation, lowering of the water level in the reservoir causes the regulator to operate and move the dial switch to the first control point, actuating contactor C_1 and starting the 60-hp. motor, by means of its automatic compensator. Assume that the water level continues to drop and closes the second point of the dial switch. This would cause contactor C_4 to close and make the control circuit for the 100-hp. motor's automatic-compensator panel, which will start the motor. A holding circuit for contactor C_4 is made through one of the contacts of contactor C_2, and contactor C_4 remains closed. A normally closed interlock on C_2 opens the control circuit of the automatic compensator of the 60-hp. motor and shuts down this motor. This scheme is followed on the remaining points. On the third control point of the dial switch the 150-hp. motor starts and the 100-hp. motor ceases to operate. On the fourth point the 60-hp. motor is again started, the 150-hp. motor continuing to operate. On the fifth point the 100-hp. motor again starts and the 60-hp. motor ceases to operate. On the sixth point the 60-hp. motor again starts and all three motors operate simultaneously. Six combinations are thus obtained which are as follows:

Control Point on Dial Switch	Motors in Operation
First	60 hp.
Second	100 hp.
Third	150 hp.
Fourth	60 and 150 hp.
Fifth	100 and 150 hp.
Sixth	60, 100 and 150 hp.

In order to provide operation of but one of the pumps during certain periods of time, as previously mentioned, a time switch and control relay *A* contactors were used. During normal operation the contactor is closed and all the pump motors start on their respective points. During the period of shutdown, however, the tips of the time switch open and contactor *A* drops out; as a result, only the 60-hp. pump motor operates, regardless of the position of the dial switch.

*Boiler Feed-Water Purification—III**

Filtration by Gravity and Pressure Filters

Types—Economics of Filtration—Sand Filters, Slow and Rapid—Mechanics of Filtration—Design of Rapid Sand Filters—Back Washing—Pressure Filters

BY SHEPPARD T. POWELL
Consulting Chemical Engineer, Baltimore, Md.

FILTRATION is the act of passing a liquid through a porous material for the purpose of removing the suspended matter contained therein. Many substances have been used and are being used for filtering water for feed-water purposes. Sand, coke, charcoal, excelsior, shavings, marble, magnetite, canvas and many other filter media have been used. In the majority of the larger installations filtering cold

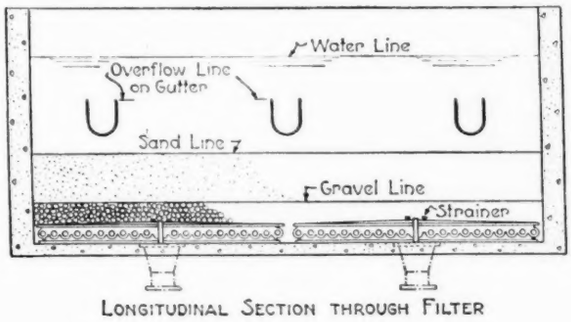


Fig. 1—Rectangular rapid sand filter

feed-water, however, sand or similar material is employed. Filter equipment for the purification of water for industrial uses is practically the same as that used for sanitary purposes.

Slow sand filters, sometimes called merely "sand filters" or "English filters," are beds of fine sand ranging in depth from 18 to 36 in., which rest on some form of underdraining system, and through which the water is passed at relatively slow rates (two to five gallons per square foot of filter area per hour). The process is not well suited for the clarification of boiler feed water since it is unduly costly and inflexible in operation.

Rapid sand filters, frequently termed "mechanical" or "American" filters, are units operated at high rates (two to five gallons per square foot of filter area per *minute*), which depend upon the use of a coagulant to aid in the removal of suspended solids. The water passes through the bed of sand in rapid sand filters by gravity. When the surface of the sand becomes fouled by the material strained from the water, the sand may be washed by passing clean water through the bed in the reverse direction to the filtering process.

In some units the sand is agitated during the washing period by revolving rakes or by compressed air. In many of the recently designed filters the agitation of the sand is effected by the high velocity of the wash water. Rapid sand filters are used extensively for the treatment of water for municipal and industrial purposes. The process is applicable to the conditioning of feed-water, either as a complete system or as an adjunct to softening or other processes.

Pressure filters are essentially the same as rapid sand filters, with the exception that the filter material is contained in a closed steel tank and the water is forced through the filter under pressure. This form of filtration has found favor in the industries and especially for the treatment of feed-water, since the apparatus may be interposed in the water main under pressure.

Coke filters are used to some extent, either alone or as an adjunct to sand filters, principally for the removal of iron and manganese from water containing objectionable amounts of these substances. The main purpose of these appliances is aëration and pretreatment for other forms of purification.

The removal of suspended solids, by passing water through a porous medium, is primarily a mechanical action. Many of the solid particles are prevented from passing through the interstices in the filter because

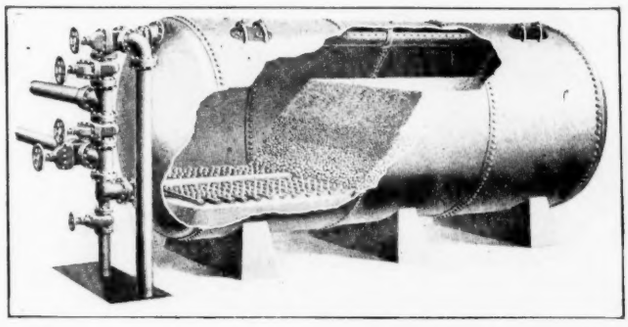


Fig. 2—Horizontal steel pressure filter (Permutit)

of their size. This action alone will not usually effect complete clarification; finely divided solids may be eliminated only by the formation of gelatinous films around the sand grains. In some sand filters the filming of the sand grains is brought about by biological action and is accomplished in the rapid sand filtration process by means of chemical coagulants. The sand bed which has been so conditioned is a porous medium in which the interstices between the sand grains have been so greatly reduced as to prevent the passage of the finely divided particles of suspended matter.

Rapid sand filters are either rectangular or circular in shape and are constructed of wood, steel or concrete. In the bottom of the filter is the underdraining system to collect the filtered water and also to distribute the wash water. Over the underdrains is placed a bed

*The preceding articles of this series were "Natural Waters and Their Impurities" (July 6) and "Getting Rid of Impurities by Sedimentation and Coagulation" (July 13).

of graded stone or gravel ranging in depth from 8 to 20 in. On this is placed the sand to a depth of from 24 to 36 in. The units are equipped with the necessary valves for controlling the flow of the influent and the effluent, controllers for maintaining uniform rates of flow of water through the apparatus, loss-of-head gages, etc. In Fig. 1 is shown a sectional view of a rectangular rapid sand filter.

Many special features have been embodied in rapid-sand-filter design, but the principles of operation are essentially the same in all installations. The passage of water through sand for clarification is a relatively simple process. Filter efficiency will depend, however, on the proper design of the units and the accuracy of the control of the process.

Sand is the most important medium used for the filtration of cold water. The choice of the right grade and sizing of sand and depth of the bed is important. Pure quartz sand, free from loam, clay or acid-soluble material is desirable. The size of the sand preferable varies with the kind of water to be treated, the rates at which the filter is to function, the depth of the bed and other factors. Sand for use in filters employed for feed-water treatment should be chosen as carefully as that for use in the treatment of water for sanitary uses.

The cleaning of filters is termed generally back washing. There are two methods of accomplishing this result: (a) By passing filtered water upward through the filter at relatively high velocities (12 to 15 gal. of water per minute per square foot of filter area) without other means of agitating the sand bed; (b) by passing filtered water at the rate of 7.5 to 10 gal. of water per minute per square foot of filter area, upward

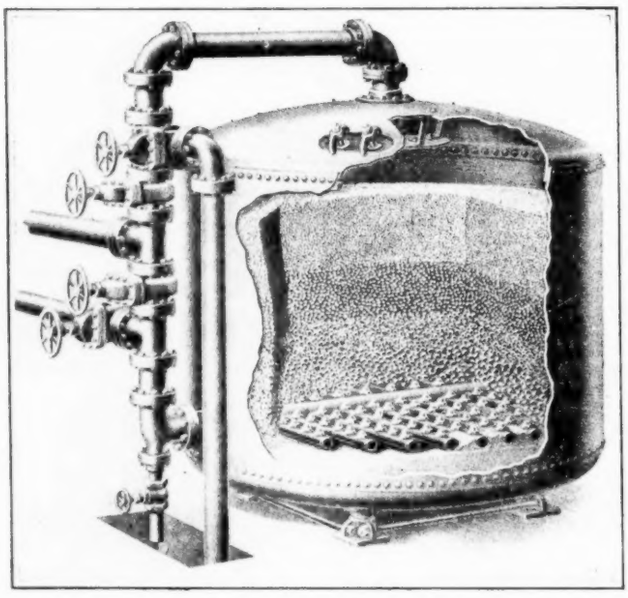


Fig. 3—Vertical steel pressure filter (Permutit)

through the filter medium, while the bed is agitated by means of revolving power-driven rakes or by the use of compressed air. These methods of washing are termed respectively high-velocity wash and low-velocity wash. The use of either method depends on the construction of the filters, and installations designed for functioning one way may not ordinarily be operated otherwise without radical changes in construction details. Mechanical agitation of sand by rakes has not been employed to any great extent in recent years. Air agitation also is not favored by many engineers.

Pressure Filters Suitable for Boiler Plants

Pressure filters have been used for many years in this country and abroad for the clarification of water. As a system of treatment for boiler feed-water, they have been far more common than the gravity type.

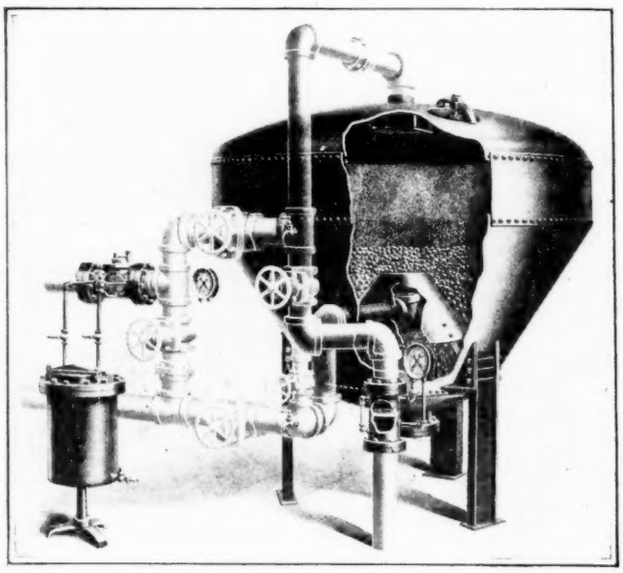


Fig. 4—Strainerless conical pressure filter (Cochrane)

Filter units are built in two forms, horizontal and vertical. The former is adaptable primarily for filtering relatively small amounts of water and the latter where greater volumes are required. These two type of filters are shown in Figs. 2 and 3.

The general construction and operation of this form of filter is essentially the same as in the rapid sand gravity unit. Pressure filters are operated as positive-head units, since the filter medium is contained in a steel tank and the water is forced through the units under pressure. They are installed with or without primary coagulation and settling.

In some installations one compartment of the filter shell is used as a settling chamber. This arrangement is of little value, since the time of detention of the water is so short that only a small amount of suspended solids is removed. Separate settling basins are necessary in the treatment of muddy water and should be used in all installations where the raw water is highly turbid. In practically all cases, however, the efficiency of the units is improved if precoagulation is provided.

In the operation of most pressure filters the water enters the top of the unit, is distributed by means of a trough or perforated pipe and is filtered by passing downward through the filter medium. The filtered water is collected by the underdraining system and discharged from the unit through a manifold. The underdrains are practically the same as those used in gravity units. When a coagulant is used, it is applied to the raw water at some point on the raw-water line ahead of the filter. Where precoagulation is possible, the water is treated as it enters the basin. The depth and grading of the gravel and sand beds vary widely.

Vertical pressure filters range in sizes from 12 in. to 96 in. in diameter and the horizontal filters are from 6 ft. to 8 ft. in diameter and from 8 ft. to 25 ft. in length. The filter shells of small units are of cast iron or steel, but the large units are practically always built of steel. The shells are designed to withstand working pressures in accordance with the pressure of force mains supplying the raw water. It is common practice to have standard equipment to withstand working pressures of from 65 to 100 lb. per sq.in. The filter medium employed is generally sand or quartz, although charcoal and other substances are of advantage in some instances.

The most radical change in design of pressure filters that has been placed upon the market recently is the Cochrane Strainerless filter (Fig. 4). This is conical in shape instead of cylindrical, and it contains no strainer system. When the unit is in service, the raw

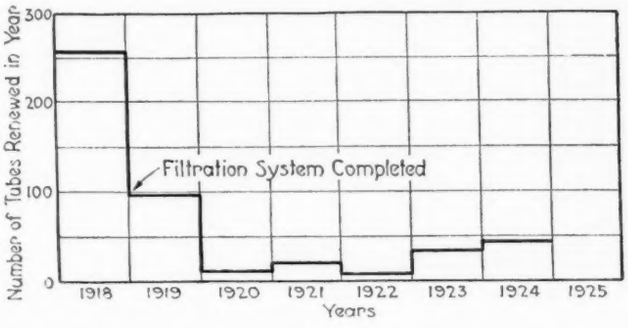


Fig. 5—Effect of installation of filtration system on tube renewals at large central station

water enters at the top of the apparatus and flows downward through the sand and gravel. The clarified water passes up under the take-off cone and out the effluent pipe. This pipe is large enough to reduce the velocity of the water leaving the filter below that which might carry away sand.

An added advantage claimed for the apparatus is that due to the shape of the shell. The area of the cross-section increases from the bottom to the top of the unit. This feature results in reducing the velocity of the wash water as it passes upward through the filter, permitting relatively high wash-water velocity as the water is discharged through the gravel, thereby carrying upward any sand that may have penetrated into the gravel bed. At the same time it insures sufficiently low velocities through the sand bed so as not to carry sand away with the wash water as it is discharged to the sewer. The apparatus weighs less than standard units of the same capacity.

Some filter installations have been designed and operated abroad in which the direction of filtration may be upward or downward. Other units are used in which the sand is agitated by revolving the filter shell during the back washing. These appliances have not found wide use in this country.

From time to time discussions have appeared in the technical press as to the relative merits of pressure and gravity filters. Many of the seeming advantages of gravity filter over pressure units are applicable only when considering the relative merits of these forms of water treatment for sanitary purposes. The same arguments may not apply in boiler-plant work. Considered from this viewpoint, the advantages and disadvantages of pressure filters for industrial use may be summarized briefly, as follows:

a. They may be interposed in the water mains under pressure, thereby eliminating low pumping.
b. Less space is required generally for pressure than for gravity filters of the same capacity.
c. They can be constructed rapidly.
d. The construction cost is relatively low.
e. They may be operated at a high loss of head.
f. More units may be added without materially affecting the general design of the installation.

Disadvantages

a. The filter sand is not easily inspected, and the efficiency of the back-washing of sand cannot be observed.
b. Application of the coagulant is usually not so well controlled as in gravity units.
c. There is danger of passing undecomposed alum through the filters, due to the short period of reaction possible between the point of chemical application and the passage of water through the apparatus.
d. The passage of sand into a filtered water system is possible when the underdraining system fails, since no clear-water storage basin is provided in most installations.
e. It is more difficult to maintain constant rates of filtration with pressure filters than with gravity filters.

The results obtained with any form of water purification will be proportional directly to the care exercised by the operator in the control of the process.

No water purification system can be efficiently controlled without routine tests of the raw and treated water and records of the essential operating data. These records should include chemical tests of the untreated and treated supply, volume of water purified daily, amount of wash water used, length of time between cleaning units, efficiency of the process, etc.

Filtering is warranted whenever the feed water contains any appreciable amount of suspended solids. The return on the capital investment of the apparatus will be proportional to the amount and character of the suspended solids and the efficiency of operation. Finely divided suspended solid matter in feed water is an important factor in the foaming and priming of boiler water, increases blow-down and is frequently the cause of burned tubes.

Grease, sewage and trade-waste products reduce the value of feed water greatly. These substances may be eliminated or reduced in the water by well-chosen and efficiently operated filter systems. The reduction in tube renewals affected by filtering the feed-water supply of a large steam station is shown in Fig. 5.

The raw water at this plant is excessively turbid at certain seasons although during the greater part of the time the water is relatively clear. The over-all annual saving resulting from the operation of this system amounted to about forty thousand dollars.

The cost of filtration, including the capital and operating charges, fluctuate widely for different systems and varying operating conditions. These costs range from six mills to four cents per thousand gallons of water treated.

A Refrigerating Engineer Says
Study the Pumping Problem

BY K. VAN DE COP

ENTIRELY too little attention is given to the pumping problem in the refrigerating plant, and few operators are in a position to know with any certainty the economical limit of pumping water to ammonia condensers. Is it better to pump more water and reduce the head condenser pressure at the cost of pump power, or is it better to save pump power and permit the head pressure to rise? In most plants the answer given to this problem is a haphazard one. There seems to be no attempt made to adjust this on a scientific basis because not much importance is attached to the possible savings in this direction.

Each plant has a different set of conditions, so each case is an individual problem. In certain instances it

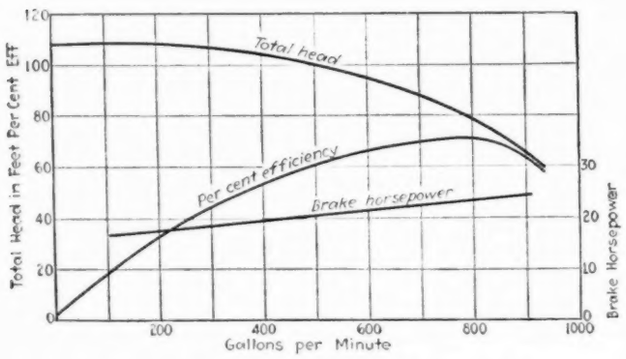


Fig. 1—Condenser pump characteristics

is imperative to hold down the head pressure regardless of pumping economy, but this is seldom the case.

It is clear that with an increase in the amount of water pumped over the condensers, the temperature range of the water on and off the condensers is reduced and the temperature of water leaving the condensers will be less and, therefore, the head pressure will be less. For each pound reduction in head pressure there is a saving of about ½ of 1 per cent of the compressor power. This saving is important in proportion to the total work done; that is, in the summer, under heavy loads, the saving of 1 lb. in head pressure is vastly more important than the same saving in winter with reduced load.

Economy in Extra Pump

As a rule, the pumping equipment in a plant imposes close restrictions on the quantities of water available for condenser circulation, so that often it is economy to buy an extra pump for the greater flexibility and economy. But even within the limits imposed by the available equipment some fluctuation is possible in the supply of water to condensers.

There are various things to be considered in order to arrive at a decision.

With tower-cooled water we have to take the operation of the tower into account. For ammonia-condenser service towers are usually figured on a small range of water cooling, about 5 deg., and are therefore designed to handle about 6 gal. per min. per ton of refrigeration and cool this water to within 5 deg. of wet bulb with a 5-mile wind velocity. The figures are approximate and subject to variation. If now the tower is overloaded, the approach to wet bulb is not so close as 5 deg., therefore if we pumped more water over the tower and condenser, it would reach the condenser at a higher temperature than a smaller amount of water and partly defeat our purpose of reducing the head pressure. On the other hand, if we pumped less water than the tower capacity, say for example, 2 gal. per min., the water would increase 15 deg. in temperature in going over the condensers, and with a 15 deg. range it also would not cool to within 5 deg. of the wet bulb if the tower had been designed for 6 gal. per min. per ton of refrigeration. In other words, if the tower is greatly overloaded or underloaded, it will not cool water to the lowest possible temperature.

Speeding Up Water Velocity

In the case of vertical shell-and-tube condensers, the heat transfer increases as the quantity of water per tube increases, so that as more water is pumped through them, the increase in water acts to make the surface more effective, which is apart from the fact that the increase of water means also reduced range in temperature. Therefore, increasing the water through these condensers has a double effect in reducing head pressure. To make this clear, consider two cases: First, 2 gal. of water per minute per ton of refrigeration with 1.4 gal. of water per condenser tube and, second, 6 gal. of water with 4.2 gal. per tube.

In the first case, the water range on and off the condensers will be about 15 deg. and the heat transfer through the tubes will be about 100 B.t.u. per hour per deg. per square foot for 2½-in. tubes. In the second case, the water range will be about 5 deg. and the heat-transfer coefficient will be about 190 B.t.u., which means that the mean temperature difference between the ammonia in the condenser and the water is about one-half that in the first case. Since the mean temperature of the water is 4½ deg. less in the second case, we have the double benefit of lower mean water temperature and lower mean temperature difference beetween water and ammonia.

In studying the question of quantity of water to be pumped, where centrifugal pumps are used we require the curves of the particular pumps in question. Fig. 1 shows a typical set of curves, which give the variation of head, efficiency and brake horsepower with various capacities, so that if any one of these four quantities is known, the other three can be determined from the curves.

Many operators make the mistake of assuming that a pump rated at 1,000 gal. per min. delivers that amount, without taking into consideration the conditions under which the pump works. As will be seen, the rated capacity is the capacity at maximum efficiency, but it is the head imposed on the pump that determines the capacity.

Exact knowledge of what the pumping conditions are enable the operator to determine what economy can be effected by changing his pumping conditions at any particular time.

Many plants are limited to a single pump for condenser service, which is poor economy.

Proof of Argument

As an example in pump economy, consider a plant whose peak load is 200 tons of refrigeration and suppose it has duplicate pumps of the type whose characteristics are shown in Fig. 1.

Assuming creek water at 70 deg. is available and a single pump is delivering 800 gal. against a total head of 80 ft., of which 16 ft. is assumed as pipe friction. This gives good conditions as regards economy. However, in the spring and fall months the load will drop to, say, 100 tons of refrigeration.

If we pump 800 gal., we have the following conditions with a mean temperature difference between water and ammonia of 3½ deg. and a 3¾-deg. water range.

Water on condenser, deg. F	70
Water off condenser, deg. F	73¾
Temperature of liquid, deg. F	76¾
Head pressure, lb. gage	130
Indicated horsepower per ton	0.965
Brake horsepower per ton	1.05
Pump horsepower	23.5

If, however, instead of 800 gal., we pump only 400 gal. per minute we have:

Water on condenser, deg. F	70
Water off condenser, deg. F	77½
Temperature of liquid, deg. F	79
Head pressure, lb. gage	135.8
Indicated horsepower per ton	1.005
Brake horsepower per ton	1.09
Pump horsepower	19.5

The increase in compressor power is $0.04 \times 100 = 4$ b.h.p. more than if 800 gal. were pumped.

To pump 400 gal. per min. with the available pump requires 19.5 hp., so that the saving in pump horsepower is 4 and is offset by the loss in compressor horsepower.

What Another Pump Means

However, if we had installed another pump of 400-gal. capacity with 69 per cent efficiency, we would show a saving. The friction head, instead of being 16 ft., would be reduced to about 5 ft., because it takes very much less power to push 400 gal. through a pipe than 800 gal. The total head would be 11 less, or 69 ft., and the brake horsepower required for the new pump would become $400 \times 69 \times 8\frac{1}{3} \div 33{,}000 \times 69 = 10$, or the pump saving against pumping 800 gal. would be $23.5 - 10 = 13.5$ hp. and the increase in compressor power 4, making the net gain 9.5 b.hp.

For 720 hours' operation in a month the 6,840 hp.-hr. saved represents a reduction in the power bill of over $90 a month with current at 1½c. per kw.-hr., so that an extra pump costing $500 would be a good investment. With colder water than the figures used in this example, the advantage of pump savings becomes greater, as is also the case in the winter months when less than 100 tons of work is being done.

There are but few plants where a study of the pumping situation would not result in a large saving in the cost of power.

The consistent pulling of ice is another problem ignored by many. At a recent meeting, a well-known refrigerating engineer made the statement that a 1 deg. difference in the brine temperature of a certain plant made a difference of 25 tons of ice a day in production.

To illustrate the working of this interrelation of brine temperature and ice making, assume a plant pulling ice on the schedule, outlined in the tabulation, this being a schedule observed by the writer in a number of cases.

Day of the Month	Tons Ice Pulled	Day of the Month	Tons Ice Pulled
1	112	16	130
2	100	17	124
3	113	18	124
4	124	19	124
5	120	20	127
6	95	21	120
7	101	22	118
8	128	23	116
9	124	24	110
10	123	25	130
11	127	26	95
12	110	27	123
13	97	28	130
14	127	29	125
15	125	30	119

Assume that the plant has 15½ cans per ton in service during this period, which would require for 300-lb.

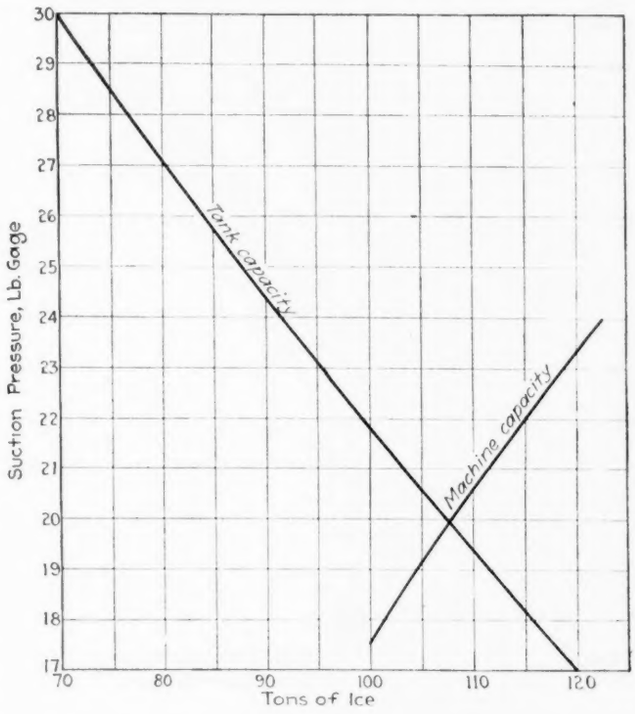


Fig. 2—Tank and machine capacity at various suction pressures

standard cans 17 deg. brine temperature if the freezing and ice pulling were done at a uniform rate.

From the first to the third of the month less ice was pulled than the average of 118 tons. Since the machine capacity was at least equal to making 118 tons, it follows that when less ice was made, ice froze in the cans ahead of the pull and a number of rows were frozen solid in the tank. The available supply of heat for the evaporation of ammonia in the coils was reduced, consequently the brine temperature and the suction pressure dropped. With reduction in the suction pressure came increased power cost for machine operation and reduced machine capacity.

The reduction in brine temperature means increased heat leakage from the atmosphere to the tank.

Ice frozen solid and left in the tank has its temperature reduced to the brine temperature. That is, with 17-deg. brine the block of ice when first frozen should have a temperature of approximately 25 deg., whereas if left in the tank with brine temperature reduced to about 14 deg., the ice will finally drop to 14 deg. It is cooled 11 deg., which represents wasted refrigeration.

The refrigeration required to offset the increased heat leakage and subcooling the ice still further reduces the machine capacity. Power consumed by brine agitators in driving brine through a bunch of frozen ice is additional waste.

Maintain a Schedule

It is thus seen that the practice of irregular ice pulling is a costly piece of business that means a continuing series of losses. By regular pulling is meant pulling all the ice as fast as it freezes. With changes in atmospheric conditions, as a sudden drop in temperature, the head pressure will drop when atmospheric cooling is used. In this case the machine capacity will increase, and the ice will be made at a faster rate than before.

This condition applies especially to compressors direct-connected to synchronous motors, whose speed is constant, and hence the machine capacity is constant unless clearance pockets be provided. Haphazard ice pulling is a costly method of manufacturing because it is not practical or possible to regulate the capacity of the machine to operate economically under these conditions.

Keep the Brine Right

The aim of the operator should be to maintain brine temperature at a pre-determined uniform level as per the following table for standard 300-lb. cans.

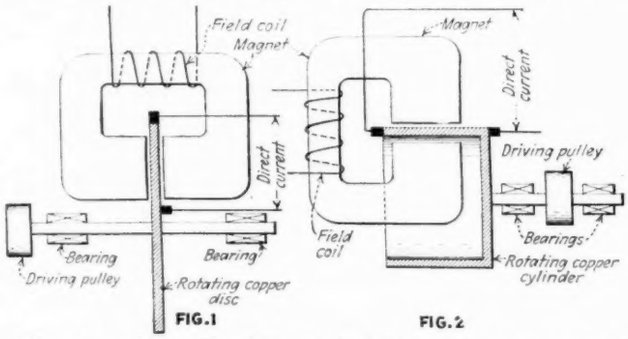
Cans per Ton	Brine Temperature, Deg. F.
13	14
14	15½
15	16½
16	17½
17	18
18	19
19	20
20	20½
21	21
22	22

To make this matter clearer, consider a plant with 1,500 cans. To make 100 tons of ice means 15 cans per ton and a brine temperature of 16½ deg., with a suction pressure depending on the amount of pipe or cooler surface, character of agitation and temperature of water to cans. Average conditions would make this pressure about 22 lb. gage. If instead of 100 tons of ice we pull only 70 tons of ice, we have 21 cans per ton and the brine need be only 21 deg. instead of 16½ deg., and the suction pressure would be about 30 lb. So that for every rate of pulling there is a corresponding brine temperature and suction pressure. This can be shown in a graphic form, as in Fig. 2. This shows that as the suction pressure falls the tank capacity increases.

A steam trap may seem a small and insignificant piece of apparatus, particularly when it is out of sight in some dark corner, yet if not in good order, it may easily waste several dollars' worth of steam a week, while the loss for the whole plant may reach an appalling total.

Direct-Current Generators Without a Commutator

An idea that has attracted the attention of many inventors and engineers is the development of a direct-current generator without a commutator. There is an old and well-known method of generating direct current without a battery or commutator, known as the unipolar or homopolar generator. The direct current derived from such a generator is continuous and has no irregularities. The action has been accomplished in two ways, as illustrated in Figs. 1 and 2. One of these, Fig. 1, consists of a rotating copper disk between the poles of an electromagnet, in which case the continuous voltage is generated between the hub and the rim of the disk. In the second case, Fig. 2, which gives the same action as in Fig. 1, a copper cylinder is rotated between



Figs. 1 and 2—Fundamental design of two types of direct-current generators without a commutator

Fig. 1—Copper disk arranged to rotate between the poles of a magnet. Fig. 2—Cylinder arranged to rotate between the poles of a magnet.

the poles of an electromagnet, causing a continuous voltage to be generated between the ends of the cylinder.

These arrangements have been used little, because there are a number of serious objections that it is difficult to overcome. The first of these is the voltage that it is possible to generate in a single disk. The single element such as pictured in the figures will readily generate 5 or 10 volts, but when an effort is made to put several of them in series, anything that acts as a connector will also act as an inductor. For instance, in the case of the disk machine, if an attempt is made to mount several disks on the same shaft between the poles of the same magnets and put them in series, connecting the outside rim of one disk to the hub of the next disk, it will be found that the connector itself induces the same amount of voltage that one disk would induce, but in the opposite direction.

In Volume 31, Part 2, p. 1811, 1912, "Transactions of the American Institute of Electrical Engineers," a description is given of the largest unipolar machine that has ever been built and put into service. It was rated at 2,000 kw., 1,200 r.p.m., 260 volts and 7,700 amp. This is a low voltage for a machine of this rating, and serious difficulties were encountered in handling the heavy current even when it meant simply the collection of this current from slip-rings and not from a commutator. As a result of the experience with this machine and others, this scheme is practically never used for commercial work, although some electroplating generators which required several thousand amperes at 10 volts and below have been built and used.

Fuel Saving Not the Whole Story

ATTENTION has long been centered—and rightly so—on the coal pile. Wanton waste of fuel is a crime against future generations and one that carries its own punishment in the shape of depleted dividends. But fuel does not tell the whole story. A good horse would generally be a better investment than a poor one (or two poor ones) even if feed were free. The low-grade "nag" would waste the time of the plowman, run up veterinary's bills, lead to expensive "shutdowns," and otherwise cause losses. It is the same with power plants where fuel is free, or practically so, as in the use of waste heat.

Blast-furnace gas may be available in excess of power demand, and there may be no customers for excess current. Obviously, fuel economy for its own sake is useless in such a case. Yet many items of modern equipment will pay. Turbine economy in steam consumption cuts down boiler-room investment. Well-designed furnaces and combustion equipment get more out of each boiler, so that fewer boilers do the work. If the feed water is bad, treating apparatus justifies itself by reducing the need for reserve boilers, increasing reliability and saving labor. So it goes throughout the plant. While it is obviously true that more refinements are warranted where fuel is expensive, first-class equipment will be found to be justified to a surprising extent even where fuel is to be had for the asking. An interesting example of just such a case is given in the leading article of this issue.

Housecleaning in Industry

THERE is going on in the industries of this country what might be called a housecleaning, under the more dignified name, "Elimination of Waste by Simplified Practice," which is carried on under the auspices of the Division of Simplified Practice of the Department of Commerce, Washington, D.C. American industry has grown very rapidly, and until the Department of Commerce, under the leadership of Secretary Herbert Hoover, began to study the situation, no one paid much attention to the expense of carrying in stock a tremendous volume of odd shapes, types and sizes.

The same condition exists in industry as in the average home. There are accumulated all kinds of things that do not pay their way, and then some day this fact is discovered and there is a general housecleaning. This is just what simplified practice in industry means—the elimination of odd shapes, sizes and styles for which there is little or no demand. When the manufacturers of milling cutters got together and studied the conditions in their industry, they found over three-quarters of a million of different shapes, sizes and styles of these cutters in existence, but it was possible to eliminate over one-half million of them from stock. A similar condition existed in the grinding-wheel industry, where nearly one-half million of shapes, sizes and styles were discarded.

Recently, the wrought-iron and wrought-steel pipe, valves and fittings industry adopted simplified practice recommendations, eliminating twenty-one per cent of the pipe sizes and nearly four per cent of the fittings. No doubt many will feel that much more than four per cent of the fittings could be eliminated. However, this is a start in the right direction and in the future this cleaning-out process may be greatly extended. One thing is essential to the success of this simplified practice, and that is the hearty co-operation of users, and in the final analysis they are the ones most vitally interested, since they pay the bills.

Justification for the 15,000-Horsepower Diesel

ONE of the outstanding engineering events of the present year was the finishing of the construction of the fifteen-thousand-horsepower M.A.N. Diesel for the City of Hamburg, Germany. Representing as it does an almost one-hundred-per-cent increase in size over the second largest Diesel in commercial use, its operating history will be examined with considerable interest by engineers of every nation.

Modern central stations of fifty thousand kilowatts and over, by employing high pressures and superheats, are able to produce a kilowatt on around a pound of coal. Owing to the low cost of coal at certain of these plants, their fuel costs are as low as is possible to attain with a Diesel using oil at current prices, and it is only by reason of the distribution loss that the Diesel can show a better power cost to the industrial factory. It would seem that in Germany the advantage would be still more obvious, since oil is comparatively costly. For these reasons there is a general feeling that the Diesels of the size of the one under discussion cannot be justified for continuous service save under exceptional circumstances.

The explanation is that the unit is intended for stand-by service. For banking, a modern steam station should not exceed one pound of coal per hour for each thirty kilowatts of rating. With a continuous twenty-four-hour banking a ten-thousand-kilowatt steam station would consume four tons of coal per day or almost fifteen hundred tons yearly. The Diesel unit, by avoiding this banking charge and assuming equality in operating costs, could bear overhead charges greater than that of a steam plant by the cost of the banking coal. On the basis of 15 per cent overhead, this means that the Diesel could cost one hundred and fifty thousand dollars more than the steam plant. While the cost of the Diesel plant is not available, on the basis of other

plant costs, it is doubtful if a steam plant could be built at a lower cost. The advantages would here seem to be with the Diesel for strictly stand-by service. It has been assumed that operating costs of a modern steam plant and a Diesel are on a parity. At present the advantage rests with the high-pressure steam plant using cheap coal. Just how many hours a stand-by plant must operate to cause the Diesel to lose its advantage depends principally upon the relative costs of the two fuels.

Nothing has been said of the maintenance. Since the stand-by steam plant is subject to rapid variation in furnace temperature, the upkeep of furnace walls and boiler walls is high and the repair expense will exceed that of the Diesel.

Taking all things into consideration, it would seem that the Hamburg municipality has not been so rash as some think in purchasing this Diesel. To the engine manufacturers the installation has manifest advantages. If such a unit operates satisfactorily, it is proof that units of from three to six thousand horsepower can be relied upon, and this range, after all, includes the maximum capacities that are actually needed in the stationary field.

Adjustable Drive for Power-Plant Auxiliaries

AN ADJUSTABLE-SPEED alternating-current motor, comparable with the direct-current type, is something for the future to produce, if ever. A great deal of effort and expense have been put into the development of such a motor, but the best that has been produced so far, falls short of the shunt-type direct-current machine both in structural features and operating characteristics. Notwithstanding this fact, all kinds of complications are endured, to obtain adjustable drives with alternating current, with apparently no other object in mind than avoiding the use of direct current.

On some power-house auxiliary drives wide ranges of speed are desirable, and attempts to apply alternating-current motors to them has led into all kinds of intricate combinations, such as two motors on the same drive with complicated control equipment. This condition has become so involved that some engineers are beginning to doubt the advantage of the electric drive over steam.

So far as the motor and control are concerned, there is no way that as flexible speed adjustment can be obtained as with the direct-current shunt motor. Speed ranges up to six to one have been obtained with field adjustment only, and ten to one with combination field and armature control. These ranges will meet all the requirements of auxiliary drives usually found in power plants.

On one large power system direct-current auxiliary drives have been used on all units where adjustable speed could be employed to advantage. The fact that after years of experience with this equipment in its older plants, this company has used it in new plants, is good testimony that direct-current drives can be applied successfully to the conditions found in the power plant. Where constant-speed drives are required, there is no question of the superiority of the alternating-current induction motor. This type is inherently a constant-speed machine, and every attempt to make it otherwise has led far afield from its chief attributes, namely, simplicity of construction and operation.

Maintaining two power systems for the plant auxiliaries has certain disadvantages, but it has been done successfully in a number of installations. In all alternating-current plants it is necessary that a direct-current system be maintained for excitation and control purposes. To extend this system to part of the auxiliary drives, would not be any radical departure from practices already familiar to operating men.

To provide high-speed elevator service with alternating current, a condition existed not unlike that with respect to adjustable-speed drives for power-house auxiliaries. In the elevator field it has in general been accepted that the solution to the problem lies in converting the alternating current into direct current and using direct-current equipment where wide ranges of speed are required, such as on high-speed elevators. Since the manufacturers began working along this line, real progress has been made in the application of alternating current to high-speed elevator service. It may be a good idea for power-plant engineers to take a hint from the elevator engineers.

Effect of Low Power Factor in Industrial Plants

ONE frequently finds low power factor in many industrial plants due to multiplicity of low voltage distribution lines and the use of a large number of underloaded induction motors. This low power factor may cause lessened economy in the operation of the plant, particularly where several main generating units are in operation. Oftentimes an additional unit is operated because the generators of the other units are up to their electrical kilovolt-ampere capacity due to the low power factor on the system.

Three 1,250-kva. turbo-generators were installed in a certain plant, and, owing to low power factor, all three were kept in operation. The actual load was only about twenty-two hundred kilowatts. Each of the three turbines was operating at less than sixty per cent capacity and hence at low economy. One turbo-generator was later run as a synchronous condenser with the turbine element rotating in vacuum. This increased the power factor on the other two units and enabled them to carry the load at about their most economical rating. Even after allowing for power to drive the motorized unit, there was a noted decrease in steam consumption as a result of this change. It may sometimes be possible to make similar changes in operating methods in other industrial plants.

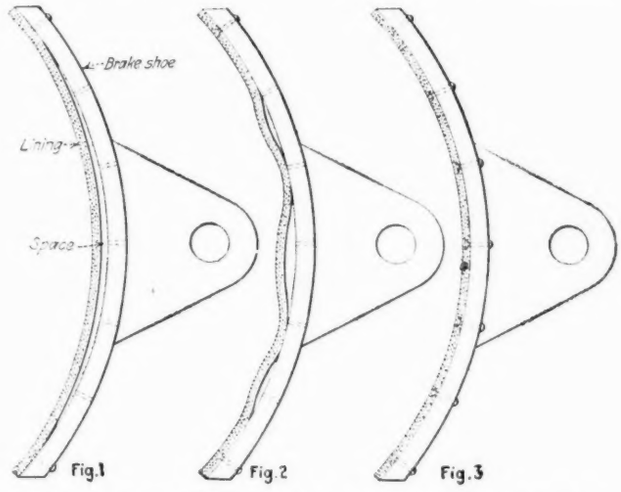
A study of the loads in the mill and a change of motors so that they are loaded more nearly to capacity is also an effective means of improving power factor.

Some central stations are operated at the full capacity of their generating units at certain times of the day. This generator capacity is occasionally limited by low power factor. This can be improved by the installation of additional synchronous motors in customer's plants, thus improving distribution efficiency, and also by the installation of a synchronous condenser to correct the power factor at the plant itself. One large central-station plant, which is almost up to capacity, is said to have increased its possible output by ten thousand kilowatts by a careful study of power factor and its correction.

Practical Ideas From Practical Men

Renewing Elevator Brake Linings

Putting the lining into elevator brake shoes is a job that requires considerable care if trouble is to be avoided. First of all, the leather lining must fit the shoe at all points, as in Fig. 3. This is necessary if the lining is to make good contact with the brake wheel. On elevators the clearance is small between the brake lining and the brake wheel, when the brake is released,



Figs. 1 to 3—Methods of putting lining in elevator brake shoes

generally about $\frac{1}{32}$ in. If the clearance is made much more than this, the brake when applied, will have a tendency to slam onto the wheel, producing a knock that may be objectionable in the building.

Figs. 1 to 3 show the wrong way and the right way of doing the work. One of the first thoughts of those not experienced with this class of work is to get the lining in good and tight and in attempting to do this they get into difficulty. The inclination is to fasten the lining to the shoes at both ends, leaving a small space between the leather and the shoe, Fig. 1, and then attempt to use the rivets to draw the leather tight to the shoes. This is wrong, as the holes in the two ends of the leather will be stretched larger than the rivets and the lining will have a tendency to turn up at the ends.

The best way to put in the lining, is to fasten the two ends to the shoe so that the leather will be slightly long for the distance between the end holes, as shown in Fig. 2. The riveting may now proceed from one end, the drilling and countersinking of the holes being done just in advance of putting in the rivets, and if care is used in putting in the leather, no wrinkles or high spots will occur in the lining. On brake bands the same rule applies, but here a much longer contact surface, extending almost all the way around the brake wheel, has to be dealt with.

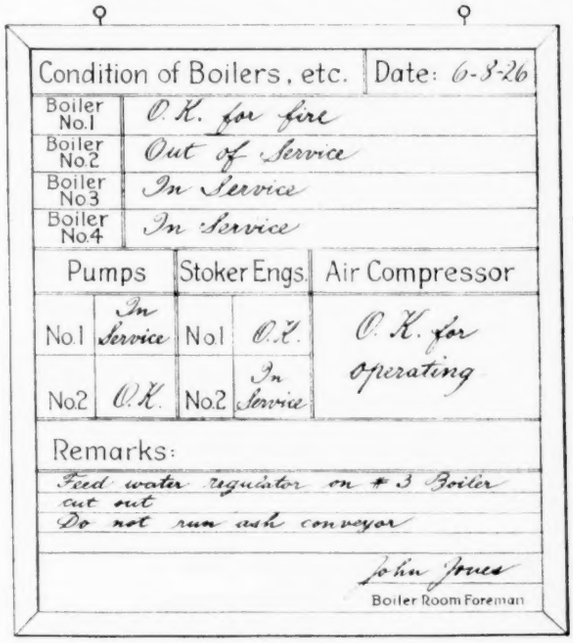
At first thought it may appear that the riveting could start from one end and continue to the other. It will be found when the work is done in this way that the lining seldom fits tight against the shoe. In putting in the leather, the object should be to get it in compression and not in tension. This can be accomplished by fastening the lining at the two ends first, and making it slightly longer than the distance between the end rivet holes as previously suggested.

Vancouver, B. C. O. G. A. PETTERSSON.

Use of Blackboard in Boiler Room Saves Time and Obviates Mistakes

For some time we have been using in our boiler room a blackboard as illustrated herewith and have found it to be very useful, as it saves time and obviates mistakes. Of course the various columns can be headed to suit the particular plant in which it is used.

The advantage of this board will be appreciated mostly in plants where the night force is limited to one or two men, as the time saved by having first-hand



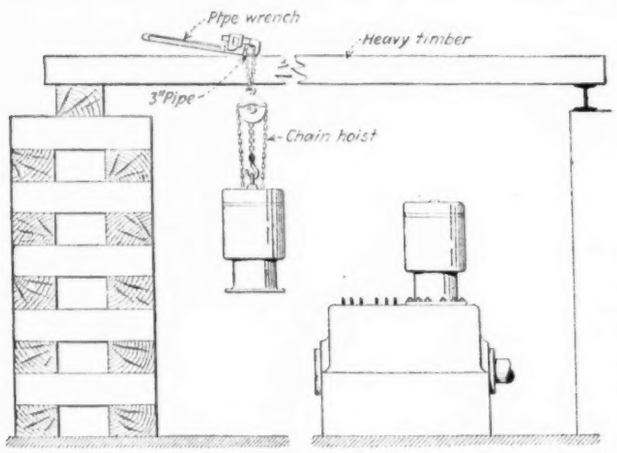
Board tells condition of equipment

information concerning spare equipment in case of a breakdown means a lot to the man on duty. In plants where there is a day boiler-house foreman, it should be his duty before going off to see that each item is correctly recorded. The night man can, in case of a breakdown or any unusual occurrence, mark it up as soon as it happens, thus obviating the danger of forgetting to tell the day force. JAMES W. GRUNDY.

Pittsburgh, Pa.

Improvised Traveling Crane

During a number of years of erection work on large gas engines, I found many plants where no means were provided for handling the heavy parts of the machines after they had been installed, so that when certain repairs were necessary temporary rigging had to be put up. The illustration shows a method I frequently



How heavy parts were handled where no permanent tackle was provided

used for lifting heavy parts and moving them to one side to place on the floor or on trucks.

Two heavy timbers placed parallel and about a foot apart are supported by blocking, or if in a structural-steel building the timbers are placed across two girders. A piece of 2½- or 3-in. pipe several feet long is laid across the timbers with a chain sling in the center from which a chain hoist is hung. After lifting the piece vertically with the hoist, it is rolled away from the rest of the machine by turning the pipe with a pipe wrench. A little lubricating grease on the pipe will make the chain slip easily.

I have used this method many times. On one occasion I removed a set of gas-engine cylinders weighing over a ton each by using two large telephone poles laid across two of the roof girders. L. M. JOHNSON.

Sewickley, Pa.

Filtering Lubricating Oil with Fuller's Earth

The usual method of removing the impurities from lubricating oil is to pass it through a centrifugal or other filter, but in my opinion a better way is to filter it through fuller's earth, as this absorbs the acids and dissolves asphaltic matters, as well as removing the mechanical impurities. If a filter bed of granular fuller's earth is made and the dirty oil allowed to run through it, the impurities will be removed and held on the top of the filter bed. The bed should be about 3 in. deep, and may be used until the scum on top offers too great a resistance to the passage of the oil through it.

The earth may be renovated by removing the sediment, etc., from the top of the filter bed, and then passing clean water through it for a time. After treatment, the oil should be tested for the presence of acids. This will check the efficiency of the filter as it is quite possible that if the oil was in a bad condition, all the acids might not be removed by one filtering. A considerable quantity of oil may be treated before the filter requires cleaning, but it is not advisable to allow it to run too long. A little experience will indicate when cleaning is necessary. After treatment the oil should be allowed to stand in shallow pans for a time, and if the filter has been working properly, the oil will be practically as good as new.

W. E. WARNER.

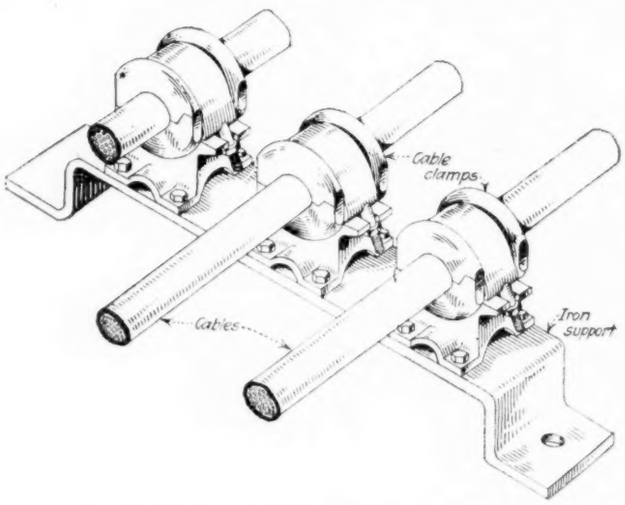
Shefford, Bedfordshire, England.

Preventing Heating of Alternating-Current Cable Supports

Sometimes the intention of doing a good substantial job leads into difficulties. One case of this was where an electrician had some single-conductor alternating-current cables to support from the wall. The usual method of doing this is to mount the cable supports directly on the wall or on a piece of timber attached to the wall. Apparently, this was not good enough for the electrician in question, and he decided to support the cables on an iron bracket, as shown in the figure.

The circuit had not been in service very long before it was discovered that the iron bracket was heating excessively. The reason for this was that the alternating magnetic field set up about the cables induced heavy eddy currents in the iron. A remedy for the trouble was found in removing the iron bracket and mounting the cable supports on a piece of 2x4 in. lumber, fastened to the wall.

Whenever it is possible to do so, it is advisable to keep iron parts 10 or 12 in. away from single-phase



How cables were supported on an iron bracket

alternating-current cables. The iron offering a much easier path for the magnetic field than air, the flux tends to concentrate in the iron, consequently the eddy current losses will be much higher than in a piece of other metal similarly located. Cases are on record where wood has been charred owing to the high temperature developed in a piece of iron it supported, being near an alternating-current cable. C. O. MILLS.

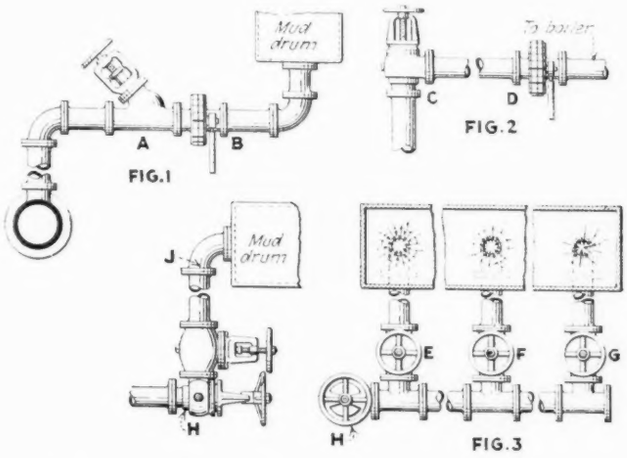
Boston, Mass.

Comments from Readers

Order of Opening and Closing Blowoff Valves

After reading the refutation of William E. Gray in the April 27 issue of the answer to the question in the March 23 issue on the order of opening and closing blowoff valves, my experience prompts me to enter this controversy as actual practice proves his theory to be inaccurate.

During my seven years' employment in one plant the boilers were blown down three times each 24 hours. Opening the outside valve first and the valve at the boiler last and closing the latter first and the former



Figs. 1 to 3—Typical blowoff valve connections

last was the usual procedure. At the end of this period the valves were still tight.

Using the same method in another plant for five years except that the boilers were blown down twice in 14 hours, the same results were obtained.

In the plant where I am now employed, the boiler blowoff valves have been in use seven years, the same method of manipulating these valves being used, and they are still tight.

Referring to Fig. 1, *A* is a Y-valve and *B* a swing-gate type blowoff valve. With this combination when operating these valves, *B* was opened first and *A* last. *A* closed first and *B* last. In about two years the stem of *A* had to be renewed, while the seat and disk were still good. Later, I had charge of a battery of boilers with similar blowoff line construction, and during five years the valves were operated in the reverse order and the only repairs required during that time was one renewal of the composition disks on the Y-valves.

In Fig. 2 *E* is an angle valve and *D* a swing-gate type valve. These valves have been in use seven years on boilers carrying 125 lb. pressure. *C* is opened first, *D* last, and the reverse in closing. They do not leak and from all appearances are good for seven years more. Referring again to Fig. 2, the valve *C* has a brass stem and I feel confident in view of my past experience that had *D* always been opened first and closed last a new stem would have been needed for *C* long ago.

Fig. 3 represents the main blowoff line and 3 branch lines *E*, *F* and *G*, connected to the mud drum of a water-tube boiler. Now, in blowing down this boiler if *E*, *F* and *G* are opened first, all at one time and *H* opened last, the action of the water will be about as indicated by the arrows if all branch pipes are clear. If *E* and *G* are clear and some scale has lodged at *J* in the center connection *F*, restricting the flow of water, there will be a tendency to reduce the flow still more by the suction action of the water rushing through *E* and *G*, therefore more sediment and scale will be deposited at *J* and later this branch will be plugged. By opening *H* first and then opening and closing *E*, *F* and *G* in turn, each pipe would be freed of scale and no stoppage would result.

Quoting from the letter by Professor Gray previously referred to: "By opening the valve next to the boiler first and closing it last, it is saved all this wear, and when the outside valve becomes worn the inside valve is still in shape to hold the water in the boiler while repairs are being made." Fine, but who wants to make any considerable repairs to the blowoff valves while the boiler is under pressure? Unless it is extremely urgent I see no particular reason for not having the boiler empty while repairs are made to the blowoff valves.

Finally, I can find just one good reason for opening the valve next to the boiler first, and the outside valve last, and that is, it will prevent a careless operator from making the final opening and the first closing too rapidly. However, that will not prevent him from too quick action unless the outside valve has a screw stem.

Brooklyn, N. Y. A. K. VRADENBURGH.

Is This Condition Prevalent?—An Answer

In a late copy of *Power* I read that 60 per cent of the engineering students who enroll throughout the country drop out before the completion of their courses. In the March 23 issue I notice that a subscriber asks that his subscription be discontinued and announces that he is quitting the game in which he has been engaged for 14 years on account of 8 cents an hour difference; he mentions that there is no responsibility attached to his new line.

Such conditions are deplorable, and in Mr. Miller's case the attitude of the employer is detestable, but could not he side-step his former employer and make a new connection that would be more profitable in the future? If he quits he will forget what he has gained through his long experience, and if he forgets, younger men in the game cannot profit by his experience.

The two articles mentioned seem to me to be closely related. In the case of the students who drop out, it seems evident that they have weighed the program necessary for keeping in condition, gaged the men who make up the 40 per cent, and then tossed in the sponge.

I remember seeing a pugilistic aspirant who was exhibiting his wares in a preliminary, crawl out under the ropes after being knocked down twice and his sponge was embarrassingly tossed in by his seconds.

At some time in our careers we find ourselves in difficulty or knocked down a time or two. We should think of our seconds or the ones who are betting on us before we crawl out under the ropes. Possibly a few words about myself may inspire someone to get up instead of crawling out.

While I realize my insignificance and feel acutely the need of a college degree, I feel that I am an engineer, a part of the 40 per cent, and intend to keep on studying as I have since I quit school, and eventually have the equivalent of a degree and more. I have never held a job that I asked for and I have never been fired. As I gain technical knowledge and profit by experience, employers will offer me better and higher paying positions.

For four years I was employed by a large company, and during this period I studied and let my superiors know of it; the company endorsed such efforts on the part of its employees by paying 20 per cent on any correspondence course. There came a time when our plant was to be discontinued and we were informed that each man would be taken care of by means of a transfer. In company with another fellow who had been devoting his spare time to study, I had a talk with the superintendent of our department regarding the nature of our transfer and learned that men who had done nothing toward improving themselves were in some instances to be given better paying places than we, when up to that time they had ranked as our equals in the payroll rating. We mentioned our efforts at improving ourselves and voiced our hopes of reward and recognition, but were informed by the department superintendent that he personally did not share the company's attitude; he hired and fired as suited his whims and cared nothing for a man's education or social standing. This was quite a blow and I handed in my resignation shortly afterward; not with any ill feeling toward the station superintendent, who had asked me to change my residence from one state to another, in order to join his shift crew and under whom I had been promoted, or with any worry that the four years had been wasted.

Almost immediately after leaving the company just mentioned, I was offered two jobs. One, with little responsibility, would pay more than I had been receiving; the other paid less, but I would be chief engineer at one plant and have charge of repairs and any new construction at another plant belonging to the company. The latter appealed to me because I would be a step beyond shift work and would have an opportunity of exhibiting any commendable individual accomplishments.

I have been employed in my present connection a little over a year, my salary has been increased and now I am assistant superintendent. Our buildings are old and the machines were not in the best of condition when I took charge. At present my plants are in better condition than when I started; old timers with the company say the engines and machines are running better than they ever ran before; the general appearance of our plants and premises has been improved by paint and a little work on our grounds, and the morale of my men is more satisfactory. I may be an insignificant member, but I am an engineer, a part of the 40 who remain in the game. JARRET LAW.

Harriman, Tenn.

Engineering and the Man

Prof. A. J. Wood discussing in the March 30 issue of *Power* my comments on "Engineering and the Man," does not question the facts I mentioned. He does not find fault with the sorry picture I drew of the average technical school faculty and its product, the technical graduate. He does not dispute the justifiability of the severe indictment of the technical faculties on several counts. He does not attempt to answer the questions I propounded and does not attempt to correct me on my answers to those questions. He does, however, find fault with one of my concluding sentences and quotes statistics in support of his contentions.

No amount of statistics will convince anyone familiar with actual conditions in industry that the demand for technical graduates exceeds the supply "three or four times over." If that be the case, what has become of the economic laws of the "supply and demand," "marginal utility," etc.? If there is such a scarcity of technical graduates, why the offer of $35 to $50 a week to graduates with 15 years' experience? At the same time, bricklayers and plasterers whose union wage is $14 per 8-hour day, are paid $6 to $8 per day bonus. If Professor Wood had a more intimate contact with industry, with records of employment offices, public, private, government, charitable, engineering societies, etc., he would modify his views considerably.

That he should use the report published in the December, 1925, issue of *Journal of Engineering Education* to support his contentions is astonishing. The report, intelligently analyzed, proves the extent as well as the results of the mistraining in technical schools.

The meagerness of the returns of those canvassed is in itself suspicious. In the commercial world the failure to file a financial statement is looked upon as financial weakness. So the failure of a technical graduate to fill out a questionnaire, may be justly inferred as "nothing good to report."

Taking the report at its face value, we find that over 90 per cent of the technical graduate's training has been technical, yet, after 5 years out of school only 28.8 per cent are engaged in technical engineering; after 10 years only 22.7 per cent; after 15 to 20 years only 17.2 per cent. On the average less than 5 per cent of the technical graduate's training has been for executive, management and sales, yet 5 years out of school 49.4 per cent are in such positions, after 10 years, 65.9 per cent, after 15 to 20 years, 70.3 per cent. It is not apparent from the report whether men selling radios house to house and men operating electrical wiring business are included in the last classification.

Assuming that the great majority of the last group are occupying real worth-while engineering executive positions, such as purchasing agents, sales managers, financiers, is it due to the training they received? Trained for purely technical work and having landed into commercial work, after several attempts at different things, a technical graduate is no more credit to his Alma Mater than a pool ball aimed at the center pocket and landing in a side pocket after two or three rebounds, is a credit to the player. That men have made good in management, executive, sales is not due to their training but rather in spite of it. For every technical graduate that has made good in such positions, one thousand men of no training at all, can be named that have made equally as good or better.

Professor Wood's argument in favor of the present system, even if we suppose that only 20 per cent of the graduates make use of their training, I am afraid will fail to convince those who have struggled for years to give their children an education and training which they thought would enable them upon graduation to care properly for their dependents and be "somebody" in private and public life. I am afraid it will find little favor with the graduates themselves who after years of struggle in college and in industry find themselves inspecting electrical wiring at $28 a week, or selling lubricating oil. I am afraid that, after reading that argument, they will question very seriously some professors' ability to carry out "The purpose of an engineering education is to teach men to think straight . . ."

E. OGUR.

New York City.

What Makes a Plant Economical?

The editorial, "What Makes a Plant Economical," in the April 6 issue, brings to mind a co-operation between factory and boiler room that took place several years ago in a dyestuff plant.

In this particular plant the boilers were taxed to their utmost, and in an endeavor to relieve this condition, a daily average load curve was drawn from the results of several weeks' running so as to give the boiler force advance information of the time the high peaks were to occur. While there was some variation from day to day, it did not seriously divert the line of the average curve.

During the summer some extra loads were added to the boiler in the form of rotary driers operating on the full boiler pressure, and several tanks the contents of which were boiled with live steam. As winter approached, it was found that the boilers would not carry over the peaks without considerable drop in pressure, so immediately, with the co-operation of the operating forces in the various departments, a study was made to determine whether or not a systematic schedule of starting and stopping times for the large users of steam could be maintained, as the various departments were run almost independent of one another.

The starting and stopping of each machine and tank throughout the plant were recorded daily for a week, along with the approximate steam consumption, and the average figures checked with the boiler-room curve. The high places on the curve coincided with the large consumption in the plant.

Between one and one-thirty p.m. a maximum peak existed. It was found that a rotary drier was started each day at about one o'clock and ran for two hours to dry a batch of color in the blue department. This could easily be held off an hour and started at two with still plenty of time to finish the batch, which was done, for between two and three o'clock the boiler load was light.

At several other times during the day the curve was smoothed out in the same way and the very high peaks were eliminated.

Signs were posted on the tank or machine which gave the time for starting the various steam users. If the men had their batch ready to dry or boil before this time, it was merely held until the scheduled time which, of course, was figured to allow ample time in which to finish the batch.

Of course, in this type of chemical work, in which products are worked through in batches and reactions are waited for, schemes of this kind can be worked out easily, where in other plants it would be impossible, perhaps, to follow these ideas. In all plants, however, if sincere co-operation is maintained between the operating force and the boiler-room crew, a more economical factory is sure to result.

Newark, N. J. RAYMOND L. DREW.

The Salesman's Value to the Engineer

I could not help giving a sigh of disappointment after reading Mr. Cowles' letter in the March 30 issue on "The Salesman's Value to the Engineer." One might conclude from his letter that his plant is a salesman's paradise.

The salesman of course fills a definite and necessary gap in industrial organizations, but to take him into the plant as a consulting engineer is a little far-fetched. An engineer should hold his position because of what he knows or what he can find out. His duty is to gather what information he can, sift out the worthless and apply the rest to his own plant for the purpose of improving conditions or saving money.

Whether he gets the information from trade literature, magazines or salesman is immaterial, but he should be capable of making his own decisions. No matter how capable or fair-minded a salesman may be, if you turn complete charge of something over to him you create a monopoly. You limit your source of information, as news of that kind travels fast among salesmen, and as they must sell to make a living, they soon begin crossing such a place off their list, as they know that no matter how good their product may be, they will not get a fair chance. If they do try to sell, they are practically selling a competitor, giving him first-hand information of their methods and product.

Manufacturers are training their men, many of whom are technical graduates, but even this with a smattering of practical training is not going to make engineers. These young men are not willing to stay out on the road long enough to be classed as real engineers with good training. The engineer should keep free of entangling alliances with any one manufacturer, but get the dope from all of them and use his own judgment.

If power-plant engineers realized what such sales organizations cost, they might not be so willing to call in a group of salesmen and keep them waiting around for days while making some paltry decision. For an engineer to keep a salesman working around a plant doing work that he should do himself and is paid for doing, is the same thing. Salesmen are anxious to explain and demonstrate their products, but they are certainly not supposed to hang around and do the engineer's work.

If a purchaser will take his bill for purchased material and divide it into two parts, 10 per cent for sales service and 90 per cent for value received, he will realize what this so-called free engineering service costs, and see that perhaps it might pay to hire an engineer capable of doing his own thinking.

I'll admit that many do not get any good out of the sales service maintained by manufacturers, but that is going to the other extreme, which is just as bad.

Bronxville, N. Y. B. MARKER.

Power and Heat Supply for Industrial Plants*

By M. K. BRYAN
Engineer with Charles T. Main, Boston

SEVERAL schemes may be used to supply the heat and power demands of industrial plants. The author points out some of the principal factors influencing the choice and draws conclusions that may serve as a guide in judging the proper application of different types of power supply.

BEFORE a power plant scheme is acceptable in a manufacturing plant, it should be commercially efficient, that is, it should justify the investment. The most desirable plan for supplying power and heat is not necessarily that which furnishes a reliable supply of each at the lowest total yearly cost, but is probably the plan, reliability considered, that supplies power and heat at the cost that makes the investment most profitable. Of two schemes supplying power and heat at different prices, the one costing the least to operate and maintain is the better if the investments in them are equal.

Return on Investment Important

If the investments are unequal, then the difference between the costs of supplying power and heat should amount to an attractive return on the difference in the investments, so as to justify the plan having the smaller annual expense; otherwise the plan costing the least to install will probably be the more attractive. If the saving does not amount to an attractive return on the investment, the plan with the smaller annual cost is not so desirable as the one costing less money to install. To make such comparisons, it is necessary that investment costs, total annual costs and savings be determined and expressed in terms of money.

Total annual costs should include all operating expenses and all the fixed expenses. Operating expenses are controlled by the demands both for power and for heat, and for this reason it is generally safer to deal with the combined cost of power and heat rather than with the separate costs of them. The costs of power and of heat are interesting items and they are necessary if departmental charges are made, but for the purpose of comparing power plant schemes, these individual costs are not needed and it is advisable not to use them.

The reliability of the scheme selected is of prime importance. The production of manufactured product depends upon reliability in the power plant, and a failure to supply either power or heat for only a short time may cause losses in production or in the spoilage of goods, the value of which would be greater than any saving possible in the power plant.

Looking to Future Needs

In addition to financial return and reliability careful thought should be given to flexibility, adaptability to reasonable expansion and ability to meet variations in the load.

Another important consideration is that of the sustained use of the power plant, or its load factor for a period of years. The daily load factor at any time is determinable, but the load factor now being referred to is indeterminate, being dependent upon the "ups and downs" in the business of the factory the power plant serves. If business continues and the factory needs for power and heat are maintained to the extent considered when estimating the schemes, then the savings should be about as the cost comparisons indicate; but if business decreases and with it the needs for power and heat decline, or if the nature of the business changes and reduces the use of power and heat, then the estimated savings will probably be reduced. There is no other way to take account of this chance than to discount the expected savings in the light of the best business judgment.

The makeup of the industrial steam power station is a combination of boiler plant, necessary in all designs as a heat supply, and a power supply provided

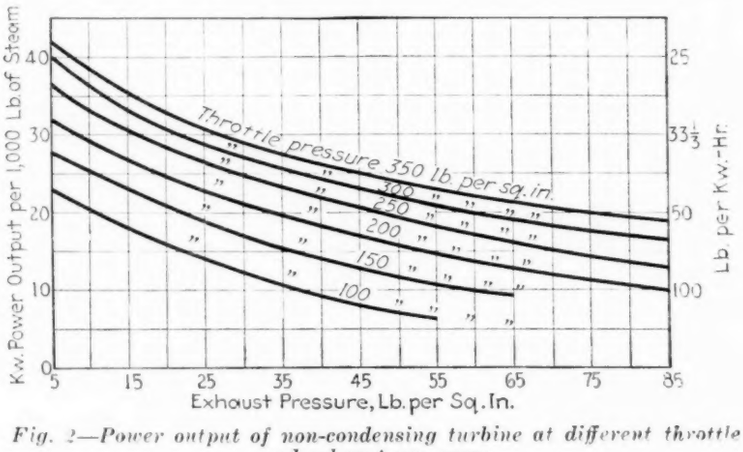


Fig. 2—Power output of non-condensing turbine at different throttle and exhaust pressures

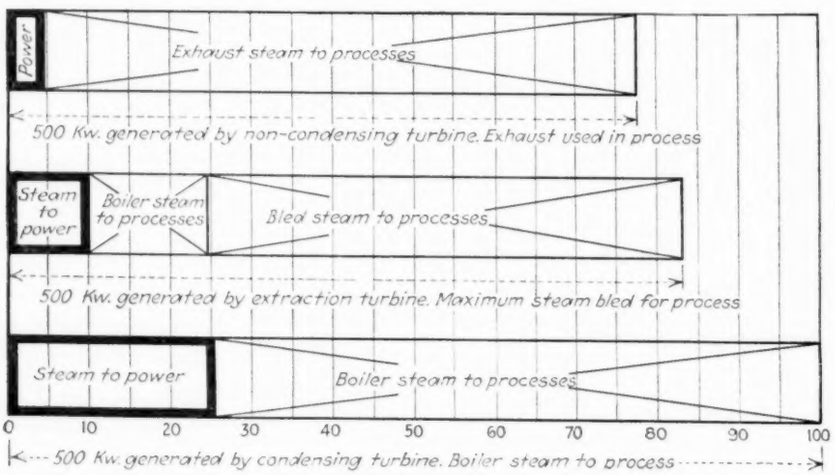


Fig. 1—Illustrating fuel distribution with non-condensing, bleeder and condensing units; power and process steam loads same in each case

*From a paper presented at the Providence meeting of the A.S.M.E.

by one or a combination of the following methods:

(1) Condensing steam power, either
  (a) generated in the industrial plant, or
  (b) generated in a public utility plant and purchased by the industrial plant, or
(2) Non-condensing steam power with the exhaust steam wholly or partly used in the processes and building heating system.

The design of the boiler plant is influenced largely by the character of the

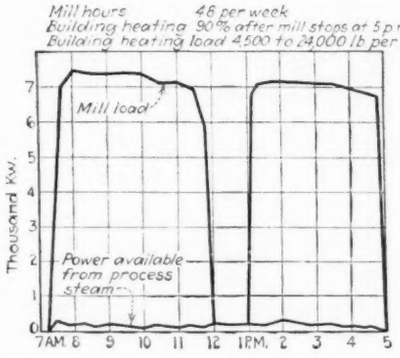

Mill hours 48 per week
Building heating 90% after mill stops at 5 p.m.
Building heating load 4500 to 24000 lb per hr
Mill load
Power available from process steam
Thousand Kw.
7AM 8 9 10 11 12 1PM 2 3 4 5

Fig. 3—Typical cotton mill load curve

load, the type of operators available, and the costs and availabilities of fuels, rather than by consideration of the uses to be made of the steam. Boiler pressure is unquestionably of importance in its effect upon the performance of power-generating units, but nevertheless the problem in arranging a source of power and heat is primarily one of using the heat in the steam to best advantage.

Effect of Turbine Development

Steam-turbine development and electric-power generation and use have had an important influence upon the makeup of the industrial power station. The development of high-economy condensing turbines of large capacity has helped public service power make a stronger bid for the industrial load, while the development of the bleeder and non-condensing turbines has made it possible for many industrial power plants to supply their product more economically than heretofore. The effect in each case is a fuller utilization of the heat in the steam.

Maximum utilization is possible with a non-condensing power-generating unit, while with the bleeder-type unit and the condensing unit the possible utilization decreases in the order named.

To illustrate this, assume a non-condensing plant with a 50-lb. water rate, a 60 per cent boiler efficiency, 9-lb. evaporation and 14,000-B.t.u. coal. This plant would generate one kilowatt-hour and supply the manufacturing processes with 42,000 B.t.u. in the exhaust steam, using 78,000 B.t.u. of coal. To supply the processes direct from the boilers would require 70,000 B.t.u. of coal. The difference in coal used, 8,000 B.t.u., is then the amount chargeable to the non-condensing generation of one kilowatt-hour of power. The latent heat of 9 lb. of condensing turbine exhaust is about 8,000 B.t.u., so unless the condensing turbine has a water rate better than 9 lb., the loss in the circulating water will be greater than the cost of power made in the non-condensing unit.

The advantage in the utilization of heat that the industrial plant may have over the straight condensing plant, by virtue of the combination of power and heat requirements, is fundamental in limiting the efficiencies of these plants. The modern central stations are taking advantage of this by bleeding the main units for feed-water heating and sending less steam to the condenser.

Condensing, Non-Condensing and Bleeder Types Compared

To illustrate the difference in one case between the non-condensing, bleeder and condensing plants, the diagrams in Fig. 1 were prepared. They represent the distribution of the fuel burned in making 500 kw. of power and in supplying a given amount of heat when using non-condensing, bleeder type, and condensing units. The same boiler plant is used in each case and the power and process steam loads are the same for each case.

In practical applications the comparisons may not be so favorable to the non-condensing unit. In the illustrations used previously, the heat needs of the processes coincided with the demands for power and at all times were equal to the heat thrown out in the exhaust, thus making it possible to generate all power non-condensing and to use all the exhaust steam. Such a condition is unusual, since the relation of heat and power demands ordinarily varies from hour to hour.

In most plants this relation is constantly changing in a manner not to be anticipated, but to avoid waste and to utilize most completely the heat, it is necessary that the power-plant scheme be set up to follow these variations.

A power supply combining condensing and non-condensing units, so arranged that the loads on each vary as the demands for process steam change, will do this. The exhaust from the non-condensing unit would supply the process steam needs, and this unit would carry a load proportional to these steam demands with the balance of the power load being carried on the condensing machine. Such conditions are fulfilled with either the bleeder-type unit, which combines a non-condensing and condensing unit in one machine, or by the combination of non-condensing and condensing machines with paralleled generators, or by a non-condensing machine paralleled with purchased power.

Accumulators Useful

In some plants having extremely variable process demands, a form of heat accumulator or reservoir may be a desirable addition to the equipment. The extreme demands for heat can be drawn from this and heat can be stored here when the process demands are light.

The amount of non-condensing power available in the steam that is used in process work is of first importance. This will depend on the boiler pressure and the pressure at which the processes must be supplied. In existing plants both of these are fixed. In new plants there is some latitude in the pressure.

The curves in Fig. 2 show how power output is affected by changes in the pressure drop through a non-condensing turbine.

Fig. 3 illustrates the power load curve of a plain goods cotton mill. It shows also the power that could be made non-condensing from the process steam used in the mill. The building heating load is variable and about 90 per cent of the heating is done after mill hours. Obviously, then, the generation of non-condensing power in such plants is not to be seriously considered and the power sources to consider are purchased power and condensing steam power.

In general it may be said that plants having steam and power loads like those of plain goods cotton mills will find it no more expensive to purchase power than to provide it in some other way, where new plants are concerned.

In making comparison of existing plants with purchased current, the results would probably be reversed, since the installation of purchased current would call for the abandonment of investment already made in a serviceable plant.

Fig. 4 illustrates summer and winter loads of a plant that uses steam for heating throughout the twenty-four hours of the day and in addition uses a small amount of process steam. The power that could be made non-condens-

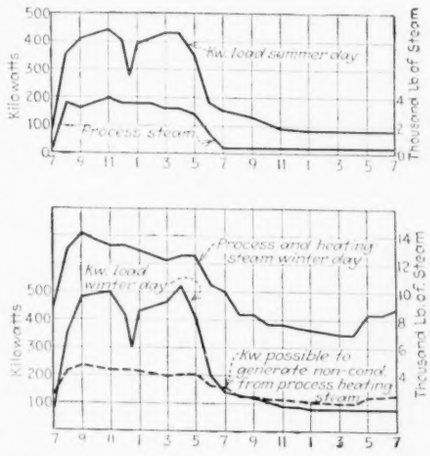

Kw. load summer day
Process steam
Kilowatts
Thousand Lb. of Steam
Process and heating steam winter day
Kw. load winter day
Kw possible to generate non-cond. from process heating steam

Fig. 4—Summer and winter loads, with combined process and heating demand

ing from the steam used in processes and building heating is shown for a winter day by the dashed curve. This amounts to about 30 per cent of the total power needs and is worthy of consideration. For this plant the bleeder-type unit or the non-condensing unit supplemented with purchased power could be considered and compared with purchased current.

A preliminary study of this problem will illustrate some of the usual handicaps of the industrial plant.

The first of these is the size of the generating unit, in this case about 250 kw., for a non-condensing machine, the unit cost of which will be higher than for a larger machine. Labor in operation will cost as much for a small machine as for a large one and more than if power is purchased. If the unit is to be installed in an existing plant, it is likely that the steam piping to

the building heating system and the processes is built to distribute steam at boiler pressure to reducing valves located in the various rooms of the factory. Such a piping system would not be large enough to distribute low-pressure steam from the turbine and the installation of a low-pressure piping system would be required and add another item of investment with its burden of fixed costs. The cost of low-pressure piping for small machines may amount to thirty or forty dollars per kilowatt.

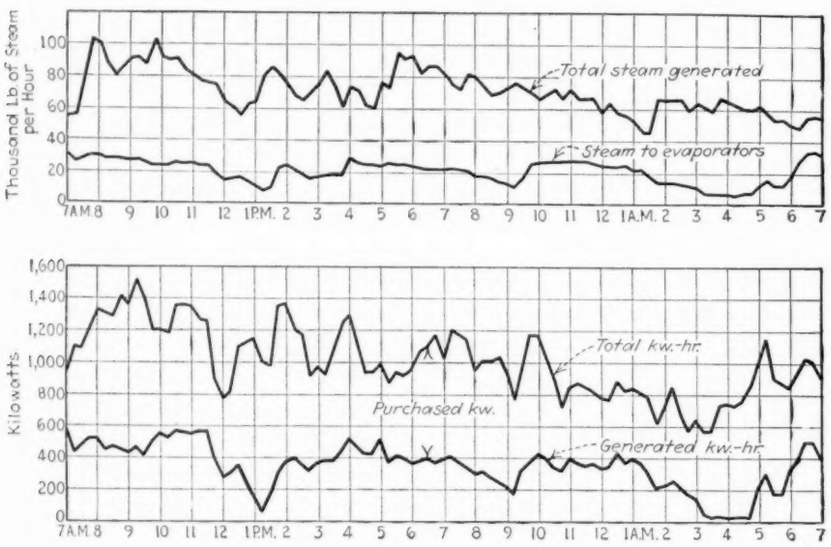

Thousand Lb. of Steam per Hour
Total steam generated
Steam to evaporators
Kilowatts
Total kw.-hr.
Purchased kw.
Generated kw.-hr.
7AM 8 9 10 11 12 1PM. 2 3 4 5 6 7 8 9 10 11 12 1AM. 2 3 4 5 6 7

Fig. 5—Steam and power loads of plant with large process demand

Because of these handicaps the plant shown in Fig. 4 could save only about $2,200 a year from the present costs with all power purchased. To make this saving, an investment of about $30,000 would be required, so that what appeared to be an opportunity to improve the power costs was not commercially feasible.

Effect of Large Demand for Process Steam

Fig. 5 shows the steam and power load curves of a plant using large quantities of process steam. The curves represent conditions for a typical day. All steam excepting the small uses of a few pumps and the stoker fans, is used in process work. The principal use for low-pressure steam is in evaporators. Other and less important uses of low-pressure steam are driers and the building heating system and boiler feed-water heating. These uses are supplied from a low-pressure piping system into which all pumps and auxiliaries and in addition a non-condensing turbo-generator exhaust. This machine runs in parallel with the public utility system supplying most of the power.

The bottom curve shows the power made by the non-condensing turbine in reducing the evaporator steam from boiler pressure to 12 lb. pressure.

This installation was made several years ago after a careful study of the process-steam and power loads. The load and pressure conditions were favorable, but there were adverse installation handicaps. The boiler pressure was 175 lb. and the plant operated 24 hours a day. Before the turbine was installed, steam was distributed at boiler pressure and reduced at the process. A low-pressure piping system was therefore necessary before a non-condensing unit could be used. The boiler plant was some distance away from the factory and the electric substation from which power was to be distributed. The turbine installation was made at the boiler house for the purpose of saving attendance and building cost, although this location increased the piping and electric feeder costs.

The installation, when completed, cost about $100 per kilowatt, imposing a burden of $12.50 annual fixed charges per kilowatt of capacity. As a further obstacle all power could be purchased for this plant at about 1¼c. per kw.-hr., an attractive price. In spite of these handicaps the installation has proved profitable and earns about $12,000 a year, 25 per cent on the investment over and above all fixed costs. This has been possible for the reason that the machine is used 24 hours a day. If the use were only 8 hours a day, the yearly saving would be reduced to about $2,000.

The unit power costs for this installation with a 24-hour load and 8-hour load may be compared with interest. They are as follows:

	Cents per Kw.-hr. 24-hr. Load	8-hr. Load
*Cost of power from turbine	0.40	1.00
Cost of purchased power:		
(*a*) Used with turbine....	1.467	2.66
(*b*) If all power had been purchased.....	1.223	2.05

* Fixed costs are 70 per cent of total for 24-hr. load. Fixed costs are 84 per cent of total for 8-hr. load.

These figures illustrate the effect of fixed charges on the power cost of the turbine installation, and show the comparative costs of purchased power and non-condensing power in this instance.

Fig. 6 shows the load curves for power and process steam in a cotton dyeing and converting plant. The total requirements for steam in process work are about equal to the requirements for power steam, although at various times in the day they differ considerably. In these and similar plants the bleeder-type unit can frequently be used to advantage. Such plants use large quantities of warm water. This requirement makes a heat reservoir, or hot-water storage, practical to level out the inequalities of the process and power steam requirements.

In the majority of the illustrations cited, the non-condensing units have appeared at a disadvantage and the impression may have been created that these units are unworthy of consideration. This is not the fact. The illustrations were chosen to point out the handicaps these machines must overcome.

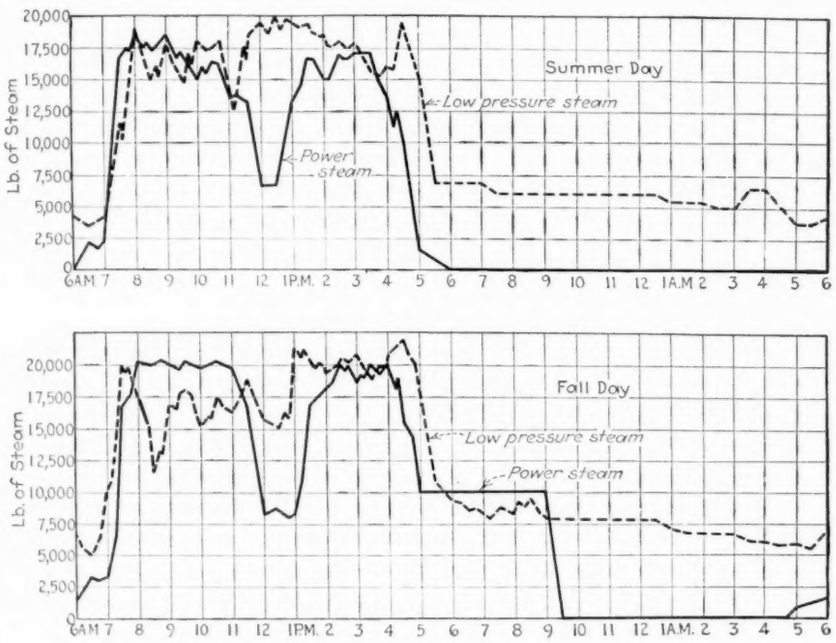

Lb. of Steam
Summer Day
Low pressure steam
Power steam
Fall Day
Low pressure steam
Power steam
6AM 7 8 9 10 11 12 1PM. 2 3 4 5 6 7 8 9 10 11 12 1AM. 2 3 4 5 6

Fig. 6—Power and process steam load in cotton-dyeing plant

No very definite conclusions are possible regarding the selection of a source of heat and power for an industrial plant. The public utility should be, and generally is, able to sell power to industries to their advantage as long as the needs for low-pressure steam are small. If the industry has a use for low-pressure steam heat large enough so that from 15 to 20 per cent of its power can be made as a byproduct of heat supplied to the processes, then plans to make this power should be considered. Studies of these propositions should be based on carefully selected data, and the total costs of all power and heat as made in different ways should be compared and analyzed.

Turbine Efficiency

The fuel consumptions chargeable to steam-turbine operation vary so widely with steam conditions and the different heat cycles that it is often hard to determine the relative thermal advantage of each of several arrangements. This situation is due in part to the difficulty of getting a true comparison. On the one hand there is the thermal efficiency (low on the percentage scale) in which the operator is interested because it directly affects his fuel consumption. On the other hand, there is the stage efficiency (high on the percentage scale) which is the index of perfection of the intrinsic design of the unit and in which the designer is interested. In addition to these two efficiencies there are also the turbine efficiency, the cycle efficiency and the reheat factor, all equally important and all interrelated and also dependent on the steam conditions. In this connection a few definitions will help.

A Few Definitions

There are certain fundamental relations among *stage efficiency, reheat factor, turbine efficiency, cycle efficiency and thermal efficiency* which by means of certain definitions may be confined wholly to the properties of expanding steam. These relations have been discussed in the literature and usually give the impression that the subject is very complicated. But the charting of the various values shows that many effects are so nearly negligible that the relations become simple and easy to handle both for the Rankine cycle and for the extraction cycle.

Turbine efficiency is the ratio of the power output at the shaft to that theoretically available from the flow in the blade system and interstage packings, between the pressure and superheat at the first nozzle entrance and the pressure at which it finally leaves the blade system.

Cycle efficiency refers to the ratio of the heat theoretically available for useful conversion to the net heat supplied in the steam, and *thermal efficiency* is the product of turbine efficiency and cycle efficiency giving the ratio of the power output at the shaft to the net heat supply, due credit being given for throttle, high-pressure packing, and leaving losses.—*Ernest L. Robinson in July issue of General Electric Review.*

Ohio Brass Company Reports Experience with Powdered Fuel

By F. L. WOLF

Technical Superintendent, Ohio Brass Company

THE pulverizing plant of the Ohio Brass Company's Mansfield factory was originally designed to handle five tons of coal per hour so that 85 per cent would pass a 200-mesh screen. At present, additional pulverizing equipment is being installed which will increase the capacity of the plant and give a total capacity of 10 tons an hour.

Pulverized coal is furnished for firing one 20-ton reverberatory furnace, six annealing furnaces having a capacity of 20 tons each, and two 3,500-sq.ft. inclined water-tube boilers.

The pulverizing equipment is housed in a fireproof building 75 ft. long, 35 ft. wide and 42 ft. high to the top of the side walls. The cost of an equipment to handle 10 tons of pulverized coal per hour, such as that of the Ohio Brass Company, will run somewhere between $100,000 and $125,000, including building.

During the year 1925 two grades of coal were used which we shall designate as grade A and grade B. These coals showed the following average analyses:

	Grade A	Grade B
Moisture (as received), per cent..	2.74	2.90
Ash, per cent	3.50	6.50
Volatile, per cent	37.88	33.15
Fixed carbon, per cent	56.80	60.26
Sulphur, per cent	0.45	0.48
B.t.u.	14,000–14,500	14,000–14,500
Fusion point of ash, deg. F	2,584	2,550
Specific gravity	0.375	0.4369

Operating Results

The following data were taken from the records at the Ohio Brass Company and cover all the elements that entered into the pulverizing of 8,400 tons of coal during the year 1925. The items of interest on the investment and depreciation are not shown.

Total tons coal pulverized.....8,400
Total hours drier operated.....1,186.75
Total hours mill operated.....2,086
Total tons of coal dried per ton of coal 128.05
Total hours operator worked.....3,704

	Hours	Total Cost	Cost per Ton Coal Pulverized
Operating labor	3,704	$2,398.46	$0.2850
Repairs to building	8	4.40	.0005
Repairs to machinery	166	99.97	.0119
Repairs to plumbing	4	1.95	.0002
Maintenance of building	64	33.95	.0040
Maintenance of machinery	46	27.48	.0030
Maintenance of electric wiring	138	81.48	.0097
Alteration to building	52	29.60	.0030
Unloading, handling coal	1,616	838.54	.0998
Miscellaneous	6	3.50	.0004
Total supplies	.....	337.33	.0400
Total power	.....	5,496.24	.6540
Pulv. coal for drying	.....	424.44	.0500
Air for transporting coal	.....	595.27	.0700
			$1.2315

During the first six months of the year grade B coal was used for the most part, but on account of its erratic behavior at the melting furnace, its use was discontinued and grade A coal was used instead.

For firing the boiler grade B coal gave very good results, but did not equal that given by grade A coal.

It will be noticed that there is very little difference in the analyses of the two coals. They both carry the same heat units. The physical characteristics, however, showed considerable difference. Grade A was uniform, all lumps showing a uniform fracture and color. Grade B showed a difference in color and there was a marked difference in the fracture. Some stratified lumps showed areas which, on analysis, gave an ash content as high as 33.42 per cent.

The arrangement of the pulverizing equipment was such that the two grades of coal could not be separated; therefore, on account of the metallurgical requirements, it was necessary to standardize on one grade only and grade A was chosen. This coal comes from the Elkhorn district, eastern Kentucky, and at no time has there been an erratic shipment received. The coal is remarkably uniform and check analyses are obtained from car to car.

The boilers operate on a rating from 50 per cent normal to 200 per cent. The brickwork on the boiler settings is 8½ in. in thickness and is provided with hollow wall space which provides a means for preheating the secondary air and also serves to protect the refractories.

The distance from the burners to the bottom of the combustion chamber is 21 ft. 6 in. A short distance above the bottom of the combustion chamber is a water screen, composed of 4-in. tubes. This not only helps to prevent the ash from fusing, but also increases the boiler efficiency.

To date, after 27 months' operation, the brickwork in the boiler settings is in perfect condition. No repairs or replacements have been made.

Analysis of the waste gases show a CO_2 content of 12.5 per cent. This could be raised to 14 per cent, but by so doing would probably mean a much more severe service on the refractories.

The boiler plant at the Ohio Brass Company is used only for the purpose of furnishing steam for heating and for process work. Power is purchased from the Ohio Public Service Company. A 250-kw. turbine unit which is connected to the main switchboard has been installed and is to be used to furnish a limited amount of power to take care of the pulverizing plant and other special equipment, should the central station power be cut off.

Both boilers are equipped with fuel oil burners which, in an emergency, can be placed in service in about five minutes.

With the use of powdered coal the boiler house is kept spotlessly clean and working conditions are ideal.

*Based on information in an article which will appear in the July-August *O-B Bulletin.*

News in the Field of Power

Charles A. Coffin, Founder of General Electric, Dies

Charles Albert Coffin, founder and former chairman of the board and president of the General Electric Co. died July 14 at his home in Locust Valley, L. I.

Mr. Coffin was president of the General Electric Co. for many years and received from his associates much of the credit for the rapid and sound development of the company. One of his achievements was the organization of its research laboratory at Schenectady, N. Y.

Mr. Coffin was born in Somerset County, Me., in December, 1844. He did not have much formal education, but years later several colleges honored him with degrees. He received honorary degrees from Union, Bowdoin and Yale.

Mr. Coffin was president of the General Electric Co. from its organization until June, 1913, when he was made chairman of the board. He retained this office until 1922.

Won Legion of Honor

Early in 1915 Mr. Coffin organized the War Relief Clearing House. It was later consolidated with the Red Cross, and he was active in the American Red Cross throughout the war. France made him an officer of the Legion of Honor and he also was made a commander of the Order of Leopold II by Belgium and a member of the Order of St. Sava by Serbia.

Mr. Coffin was a member of the Chamber of Commerce of New York and the Metropolitan Museum of Art and formerly was a trustee of Vassar College. His clubs included the India House, Piping Rock, Creek Union League, Metropolitan, National Arts and the Bankers'.

Established Coffin Fund

Four years ago the General Electric Co. established a fund of $400,000 to be known as the Charles A. Coffin Fund. The income was to be devoted to encouraging the study and the application of the science of electricity. In commenting on the fund a *New York Tribune* editorial said that Mr. Coffin was "gifted with the breadth of vision that enables him to visualize business as something more than an opportunity to pay fair wages to workers and to earn fair profits for stockholders. The history of the General Electric Co. is the history of Charles A. Coffin and the history of Charles A. Coffin is one of constant striving to improve on the best that has yet been done."

"The policy and practice of the corporation which Mr. Coffin has directed," the editorial continued, "as it forged its way to a world-wide importance were the natural expressions of his keen intelligence, his wide sympathy and his ambition to achieve that success which those attain who raise the standard of mankind's comfort, safety and happiness by enlarging man's opportunity to do it for himself.

"Mr. Coffin opened new fields of employment, gave new rewards to manual skill and intellectual capacity, offered new incentive to men and women to spend their talents in bettering the world that they live in. It is in keeping with this that his monument should be a permanent foundation which will afford in the three years to come recognition and encouragement to other toilers in the calling in which Mr. Coffin's genius has been displayed."

Schwab Heads A. S. M. E. List for 1927 Officers

Nominations for officers of the American Society of Mechanical Engineers for 1927 were announced at a recent meeting of the Nominating Committee held in Chicago, Ill. Election will be by ballot of the entire membership, closing on Sept. 28, 1926.

The nominees, as presented by the regular nominating committee are:

President—Charles M. Schwab, chairman, Bethlehem Steel Corp., New York City.

Vice-presidents — Charles L. Newcomb, manager, Deane Works, Worthington Pump & Mchy. Corp., Holyoke, Mass.; E. O. Eastwood, professor, mechanical engineering, University of Washington, Seattle, Wash.; Edwards R. Fish, vice-president, Heine Boiler Co., St. Louis, Mo.

Managers—Paul Doty, chairman of Minnesota State Board of Registration, St. Paul; Ralph E. Flanders, manager, Jones & Lamson Mch. Co., Springfield, Vt.; Conrad N. Lauer, treas., genl. mgr., Day & Zimmermann, Inc., Philadelphia, Pa.

Treasurer—Erik Oberg, editor, *Machinery*, New York, N. Y.

Delegates American Engineering Council—O. P. Hood, Washington, D. C.; Dean E. Foster, Tulsa, Okla.; W. P. Hunt, Moline, Ill.: Charles Penrose, Philadelphia, Pa.; E. N. Trump, Syracuse, N. Y.; Thomas L. Wilkinson, Davenport, Iowa; D. Robert Yarnall, Philadelphia, Pa.; Walter S. Finlay, Jr., New York City; and Ira W. Dye, Seattle, Wash.

Tennessee Company Plans New Project

The Tennessee Eastern Electric Co., of Johnson City, Tenn., has applied to the Federal Power Commission for a preliminary permit covering a project on the South Fork of the Holston River near Kingsport. This application conflicts with that filed previously by the Holston River Power Co.

Meetings Over St. Lawrence Project Conciliatory

New York State and the Province of Ontario are reported to be on much more amiable terms concerning power development on the St. Lawrence River, as a consequence of a series of meetings conducted in Toronto, Canada, during the week of July 5. Engineers representing the State of New York and the Ontario Hydro-Electric Power Commission met and studied the various plans which have been submitted to the New York Water Power Commission for the carrying out of the project.

Following the conferences, a statement signed by Roy G. Finch, state engineer of New York, and F. A. Gaby, chief engineer of the Ontario Hydro-Electric Power Commission, was issued. It pointed out that the application and plans which have been filed with the New York State Water Power Commission, covering both single and two-stage developments on the St. Lawrence, were discussed in detail.

It was agreed that all plans and estimates covering all suggested developments, would be left with the Ontario Hydro Power Commission for further examination and another conference is to be held shortly to further discuss the plans proposed.

The engineers of the Ontario Hydro-Electric Power Commission offered to supply the representatives of the New York State Water Power Commission with any data they have obtained on the situation.

The delegation from the State of New York was composed of Roy G. Finch, chairman; Albert Ottinger, attorney general; Jos. A. McGinnies, speaker of the Assembly; Deputy Attorney General Randall Laboeuf; F. Williams, secretary to the Commission; Judge Ferris, counsel for the Commission, and John P. Newton, assistant state engineer.

Florida Plant Destroyed—Engineer Burned

One man was injured, perhaps fatally, and the town of Williston, west of Ocala, Fla. was temporarily without light, water or power, as the result of a $100,000 fire of undetermined origin, which recently destroyed the municipal electric, ice and power plant.

O. N. Smith, night engineer of the plant, rushed into a drug store screaming with pain from burns about the head, neck and shoulders, and with part of one shoulder blown off by an explosion which started the blaze. Physicians said he would not, in all probability, recover.

The plant is owned by the City of Williston and new equipment recently installed at a cost of $42,000 will prove a total loss.

Agreement on Shoals Rates Looms Nearer

Negotiations between the Corps of Engineers of the United States Army and the Alabama Power Co. are proceeding with prospects favorable to an early agreement on a new schedule of rates for the hydro power being developed at Muscle Shoals.

Transmission Loss Feared

In the main, the Alabama company objects particularly to the proposed condition that power from the Wilson Dam be given priority of use over that of its steam plants. It is contended that this is impracticable, as Muscle Shoals is 125 miles from the center of its load. Conditions may arise where it would be to the advantage of the company to reduce the amount of Wilson Dam power to save transmission losses. It also is pointed out that large stocks of coal are on hand at the Alabama company's steam plants. This coal is subject to deterioration and spontaneous combustion, so that the curtailing of steam power carries with it the possibility of losses from that source. Moreover, it is stated on behalf of the Alabama Power Co. that the bringing in of its Cherokee Bluffs plant in September may make it desirable to use less Wilson Dam power.

Lump Sum Offered

The power company has made a definite offer of $100,000 per month for such power as can be handled by the existing transformers. The company has laid its books before the engineer officers in an effort to establish that this is a reasonable rate for power not covered by contract for a definite period of time.

Indications are, as this is written, that some such lump-sum figure will be accepted.

New Hampshire Power Control Outside of State

The extent to which New Hampshire power stations have come under the control of interests outside that state is emphasized in a report made public by the New Hampshire power survey committee.

The need of a definite state policy which will encourage legitimate development and at the same time protect the consuming and investing public is urged. "Two-thirds of the generating capacity of central power stations in New Hampshire," the report says, "has come into the hands of two companies —the New England Public Service Co. and the New England Power Co. Both are controlled outside this state." The report points out that, at present, the State Public Service Commission has no control over holding companies and that the development of electrical operations in agriculture "has not yet seriously started" in New Hampshire.

Salmon River Project Heard by N. Y. Water Commission

The first of a series of hearings on the application of certain towns, villages and corporations in Clinton County, New York for the creation of the Salmon River Regulating District made under the provisions of the New York State Conservation Law was held July 13 and 14 before the New York State Water Control Commission at Albany. State Engineer and Surveyor, Roy G. Finch, Attorney General Albert Ottinger and Conservation Commissioner Alexander MacDonald constitute the personnel of the commission.

The petitioners propose to impound water in a natural basin on Salmon River near Titusville, Franklin County, in area approximately 4,200 acres and a four billion cubic feet water storage reservoir.

Decision of the commission will not be had until after evidence is received and transcribed, and its final determination is subject to court review upon application of a freeholder residing within the district. Adjournment was made to Sept. 1, at Albany, when further testimony will be taken.

Lehigh to Require Nine Years for Degree

Nine years will henceforth be the minimum time in which the degree of "engineer" may be won from Lehigh University, says an official statement by President Charles R. Richards issued July 12. Beginning with the entering class next fall, the usual four year course will lead to the degree of Bachelor of Science in the various branches of engineering. Five years of acceptable practical experience in responsible charge of work after graduation and the submission of a suitable thesis will be required before the university will stamp a candidate as a full-fledged civil, mechanical, electrical or chemical engineer.

"Engineers cannot be trained by a purely academic process," explains the announcement of this innovation. It is predicted that this effort to raise the dignity and value of an engineering degree will be adopted eventually by other leading technical colleges.

Coincident with this change will come a revision of the courses of study by which greater emphasis will be placed on the fundamentals of engineering, mathematics, physics, chemistry and less emphasis on the specialized details of engineering practice. In addition, these revisions include an increase in non-technical subjects, such as social sciences, fine arts, and business administration.

Travel party of the American Society of Mechanical Engineers in an alpine flower bed in Paradise Valley, 5,557 feet above sea-level, in Rainier National Park, Washington. Delegates from many states stopped at Paradise Inn for a short stay, en route from the San Francisco convention, June 28-July 1.

Rival Bidders Catch Snags on White River Project

Additional data submitted by the Ozark Hydro-Electric Power Co. do not convince the staff of the Federal Power Commission that its plan for the development of the White River in Arkansas is as comprehensive as that of the White River Power Co. The Ozark company has appealed to the commission. The commission will listen to the arguments of its own staff and to those of the companies interested on July 28.

The Arkansas Railroad Commission recently announced that it had cancelled the state rights of the White River company. The company, however, contends that there is not good cause for the revocation of its rights and has carried the matter to the courts. The White River company took over the rights of the Dixie Power Co. It is a North American subsidiary. It plans to transmit the power to St. Louis.

The Ozark Co. is an Electric Bond & Share concern. Its plan is to feed the power into the interconnected system being developed in the South.

Further Canadian Power Development

Substantial progress has been made with the installation of two further generating units at the plant of the Duke-Price Power Co. on the Saguenay River, province of Quebec. Both turbo-generators have a capacity of 45,000 hp. and, with the additional 90,000 hp., the capacity of the plant will be brought up to 450,000 hp.

The Abitibi Power & Paper Co., of Iroquois Falls, Ontario, is now in the big power producing class. The company is now using all its power resources. The last unit of 15,000 hp. at the Island Falls power plant was turned on in the company's mills recently, making the total output of the power plant 60,000 hp. Abitibi's power plants at Iroquois Falls and at Twin Falls produce 55,000 hp., so that the production now totals 115,000 hp.

Work is to be commenced almost immediately on the erection of a large auxiliary steam plant, to be located either at Fernie or Elko, British Columbia, to generate an additional 5,000 kw. of power, according to an announcement made by A. B. Sanborn, general manager of the East Kootenay Power Co. The cost of erecting this plant is expected to be in the neighborhood of $1,000,000.

Germany's Power Development Phenomenal

Production of electric energy and a very material increase in the number of central power stations has developed a rapid growth in Germany. Power stations generating 20,000 kw. or more numbered 13 in 1913, 39 in 1917 and 80 at the close of 1925—an increase of 515 per cent.

The output of electric energy totaled 2,000,000 kw. in 1913, over 3,000,000 in 1922 and nearly 6,000,000 in 1924,, an increase of 184 per cent. Total sales in millions of kilowatt-hours were 4,061 in 1913 and 11,521 in 1924, and 184 per cent growth.

The movement toward concentration in the German electric industry is noteworthy. It is prophesied by leading German engineers and economists that within two decades the whole industry will be controlled by the Reich in a manner similar to the control now exercised over the railways and postal service.

This trend toward the development of unified control is evidenced by the acquisition by several of the German states of substantial interests in the leading electric enterprises within their boundaries.

Great Western Power Co. Wins Suit

A $169,000 damage suit against the Great Western Power Co., brought by the Balfour-Guthrie Co., was decided in favor of the defendants by a superior court jury sitting at Martinez, Calif., recently.

The Balfour-Guthrie Co. sought to recover for the loss of 8,000 tons of grain destroyed in the $1,000,000 fire which destroyed the Port Costa warehouse of the Port Costa Wharf & Warehouse Co. in 1924, contending that faulty transformers maintained by the Great Western Co. had caused the fire.

Portland Electric Installs Large Emergency Turbine

The Portland Electric Power Co., Portland, Ore., will install a steam turbine of 31,500 hp., the largest in the Pacific Northwest, to be used as an emergency unit. Officials state that while such a large unit is not necessary at the present time, yet its installation will provide adequately for future needs. The cost of the project will be about $500,000, and ten freight cars are required for its transportation from the factory.

Pumping Units to Prevent Water Hammer

The three large centrifugal pumping units in the new sewage disposal plant in Brooklyn, N. Y., are arranged for automatic slow-down to prevent water hammer. This arrangement was designed by the General Electric Co. as follows:

The pump motors are automatically started by a float switch and, when this closes, an oil circuit breaker is closed, thus throwing voltage on the primary of the motor. The motor then accelerates automatically until it reaches full speed. When the pump motor is to be stopped the float switch opens and a contactor drops out, thus inserting resistance in the motor secondary and thereby slowing it down. At the same time, a definite time relay is energized, tripping after a predetermined time, thus opening the oil circuit breaker and shutting down the motor.

The three pumps are driven by 125-horsepower, 4,150-volt, slip ring General Electric motors. The Brooklyn plant is one of the first installations in the country where such provision is made.

Federal Report on General Electric in December

Satisfactory progress is being made on the investigation of the General Electric Co., considering the limitations of personnel and appropriations, it is stated at the Federal Trade Commission. It is expected that the report will be ready to submit to Congress when it convenes in December.

Obituary

Charles E. Scribner, who for 23 years was chief engineer of the Western Electric Co., died on June 25 at his summer home, Jericho, Vermont. He held more patents in the electrical field than any other inventor, credited with a total of 441. For six years prior to his retirement he was consulting engineer. In his early days he worked with Thomas A. Edison and their association resulted in a life-long friendship. The first multiple switchboards to be used commercially were of his design. Now his work is evidenced almost wherever telephonic communication is found around the globe.

Mr. Scribner was born in New York but spent the days of his youth in Toledo. He was educated in Toledo schools.

Personal Mention

David W. French, superintendent of the Hackensack Water Co., has been appointed manager, following action by the board of directors.

O. C. Merrill, executive secretary of the Federal Power Commission and chairman of the American group attending the Water Power Conference at Bale, Switzerland, will sail for Europe from New York Aug. 7.

Wilbur S. Cooper, formerly instructor of heat-power in the mechanical engineering department of Cornell University, is now assistant engineer in the bureau of research and test of the Brooklyn Edison Co.

Ernest Wooler, chief engineer of the Timken Roller Bearing Co., sailed for England July 14 to investigate the development of anti-friction bearings. He will visit the British Timken plant at Common Lane, Ward End, Birmingham.

John W. Lieb will preside at the Sept. 6 session of the Bale Power Conference. The Swiss committee recently requested the American group to select the presiding officer for the date mentioned. Mr. Lieb was chosen and has accepted the honor.

Honorable G. G. Ponti, Deputy of the Italian Parliament and general manager of the Societa Idroelettrica Piemonte and affiliated hydro-electric companies, is on a visit to this country. Professor Ponti will deliver a number of illustrated addresses on Italy's development of hydro-electric resources and industrial utilization of electrical energy.

Business Notes

The Dean Hill Pump Co., manufacturer of pumping machinery, and steam turbines, Anderson, Ind., announces the opening of a Philadelphia office at 816 Real Estate Trust Building, with R. W. Nagle as manager.

The Triumph Electric Corp. of Cincinnati, Ohio, has been organized to take over the good will, designs, records, patent rights and inventions of the Triumph Electric Co. The new company will specialize on its TR self-starter automatic heavy-duty motor and at the same time be in a position to supply its other lines of electrical and refrigerating products.

The Interoceanic Railway of Mexico makes the announcement effective July 1 that all purchasing department matters heretofore attended to by F. P. De Hoyos, 225 West 34th St., New York City, will be handled through the office of E. E. Bashford, vice-president and assistant treasurer, Room 609, 25 Broad St., New York City.

The George H. Hagan Co., furnace and combustion engineers of Pittsburgh, Pa., has appointed as representatives for handling the sale of the Hagan steam jet ash conveyor the Jampol Co., 30 Church St., New York City; H. E. Haslett, 2192 Railway Exchange Bldg., St. Louis, Mo.; R. L. Sheraton, 12 Pearl St., Boston, Mass., and Jno. H. Bricker, 816 Otis Bldg., Philadelphia, Pa.

The L. J. Wing Manufacturing Co. manufacturer of air-handling and power plant machinery has purchased the factory property in Newark, N. J., which it has been occupying for the last five years, and will immediately erect an extension to the present building, increasing its capacity about 50 per cent. This company has general offices in New York City and has been manufacturing ventilating fans and exhausters, force-draft blowers, unit heaters, etc. for over 25 years.

Trade Catalogs

Draft Gages—The Hays Corp., Michigan City, Ind. An eight-page folder illustrating the various Hays draft gages and featuring the new pointer gages arranged in flat or V-type cases, the former for one or two units and the latter for any number of units up to twelve or more.

Cranes—Whiting Corp., Harvey, Ill. This is a condensed catalog of the Whiting products in equipment for use in foundries, steel plants, power stations, railroad shops, chemical works and other industries. Gantry and traveling cranes, hydraulic gates and hoists and the Grindle pulverized-coal systems, manufactured by the Grindle Fuel Equipment Co., a subsidiary of the Whiting Corp., are among the products of interest in the power field.

Pulverized Fuel Burning System—Combustion Engineering Corp., 43 Broad St., New York City. Catalog U-2 describes and illustrates the C-E Unit System for burning pulverizer fuel. This issue, just published, replaces edition U-1 and is considerably larger and more comprehensive. Some detail is undertaken to explain in the construction of the mill the feeding arrangement, grinding chamber, tramp iron pocket, fine regulation and coal removal and rotor, hammers and bearings. Many illustrations are given to make the operation of the mill easily understood.

Coming Conventions

Association of Edison Illuminating Companies. Chateau Frontenac, Quebec, Sept. 27-Oct. 1. P. S. Millar, 80th St. and East End Ave., New York.

Empire State Gas and Electric Association. Lake Placid Club, N. Y., Sept. 30-Oct. 1. C. H. B. Chapin, Grand Central Terminal, New York.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates: **New York State Association.** Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J. **Wisconsin State Association.** R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association,** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

Universal Craftsmen Council of Engineers. 24th convention and exhibit Milwaukee Auditorium, Milwaukee, Aug. 3-7.

Portable Air Compressors—Sullivan Machinery Co., Chicago, Mich. New catalog No. 83-D illustrates a number of improvements over previous designs. Important is the addition of a unit of 320 cu. ft. per min. capacity of the V or opposed type, the two pairs of cylinders being set at an angle of 90 deg. with each other, the connecting rods running to a common crankshaft. Another feature adopted is the Protectomotor Air Filter, which is now supplied both on the compressor intake and on the engine intake. The compressors are available on steel wheel mountings or on trailer trucks with spring suspension and rubber tires.

Spiral Riveted Pipe—Abendroth & Root Manufacturing Co., Newburgh, N. Y. Catalog No. 59 on cast-iron pipe fittings, sheet-steel fittings, Root bolted joints and hydraulic giants. More of the nature of a well-written text than an ordinary catalog, and profusely illustrated with photographs of the various stages of manufacture, installation and operation, this publication combines a careful study of the various types of Root spiral riveted pipe with an illustrated discussion of the many uses to which this product has been successfully applied. Outstanding among the features of this piping are its light weight and durability. A well-made index gives a ready handling.

Steam Traps—Bundy Steam Trap Co., Nashua, N. H. Five new features are claimed for the Bundy steam traps described in this illustrated and tabulated catalog. The bowl, pipes and elbows are formed integrally in one casting instead of five; utilization of the patented Bundy Liquid Coupling, together with a ground joint and Bundy self-forming packing; connecting-rod links rock on knife edges instead of pivoting on pins; new valve-stem attachment which does away with rigid connections, setscrews and check nuts, and tilting action is insured by ball-bearing lever. Boiler return traps, three valve pumping and vacuum traps, and Bundy separating or tank traps are illustrated and considered in some detail.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	July 12 1926
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.70
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.40@ 1.70
Pittsburgh	Pittsburgh	1.60@ 1.90
Pittsburgh gas slack	Pittsburgh	1.20@ 1.30
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.10@ 2.25
West Ky.	Louisville	.90@ 1.40
S. E. Ky.	Louisville	1.25@ 1.75
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.50@ 3.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.20@ 2.00

FUEL OIL

New York—July 15, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—July 6, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95 per bbl.; 26@28 deg., $2.00 per bbl.; 28@30 deg., $2.05 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 5.8c. per gal.; 38@40 deg., 6.5 per gal.

Pittsburgh—July 6, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil 6½c. per gal.

Dallas—July 3, f.o.b. local refinery 26@30 deg., $1.70 per bbl.

Philadelphia—July 8, 27@30 deg., $2.62½@$2.68½ per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.70@$1.76 per bbl.

Cincinnati—July 5, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—July 12, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.20 per bbl.; 26@30 deg., $1.30; 30@32 deg., $1.40.

Boston—July 12, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.44c. per gal.; 28@32 deg., 5.85c. per gal.

New Plant Construction

Ala., York—City, E. G. Olden, Clk., will soon award contract for the construction of a reservoir including 150,000 gal. filter plant, 750 g.p.m. centrifugal pump, 60,000 to 75,000 gal. tank, etc. R. L. Totten, B. M. Bldg., Birmingham, is engineer.

Ark., Batesville—City, E. H. Glenn, Supt., is in the market for a new 400 hp. Diesel oil engine for electric light plant.

Calif., Fresno—Fresno County, D. M. Barnwell, Clk., will receive bids until Aug. 2 for a turbine pump for County General Hospital.

Calif., Long Beach—Consolidated Properties Co., G. Cowan, Pres., awarded contract for the construction of a 14 story hotel and club building on Ocean Blvd., to Bard & Co., Pacific National Bank Bldg. Estimated cost $1,250,000.

Calif., Los Angeles—Title Insurance & Trust Co., Title Insurance Bldg., plans the construction of a 12 story office building at Spring and 4th Sts. Estimated cost $1,000,000.

Calif., Modesto—E. Solyo Irrigation Dist., voted $278,000 bonds for the construction of a steam power plant and irrigation works.

Illinois—Chicago, Rock Island & Pacific Ry. Co., La Salle St. Station, Chicago, awarded contract for the construction of a 2 track unit electric cinder handling plant at Manly, Ia. and a three track unit at Burr Oak, Ill., to Roberts & Schaefer Corp., Wrigley Bldg., Chicago. C. A. Morse, Chicago, is chief engineer.

Ill., Chicago—Huron Building Corp., c/o Levy & Klein, 111 West Washington St., Archts., will soon award contract for the construction of a 12 story hotel at Huron and North Clark Sts. Estimated cost $1,000,000. A. Epstein, 3001 West Pershing Rd., is engineer.

Ill., Chicago — E. Jackson, 608 South Dearborn St., awarded contract for the construction of a 23 story office and stores building at Adams and S. Clark Sts., to Starrett-Dilks Co., 160 North La Salle St. Estimated cost $6,100,000.

Ill., Chicago—Lake View Ave. Building Corp., S. E. Mittleman, Pres., 11 South La Salle St., is receiving bids for the construction of an 18 story apartment at 2432 Lakeview Ave. Estimated cost $2,500,000. Rissman & Hirschfield, 64 West Randolph St., are architects.

Ill., Chicago — Syndicate, c/o J. W. Stevens, 1212 Lake Shore Drive, awarded contract for the construction of a 22 story office building at Monroe and South Clark Sts., to Starrett-Dilks Co., 160 North La Salle St. Estimated cost $1,500,000.

Ill., Oblong—City will receive bids until July 23 for improvements to waterworks including deep wells, pumping station, 100,000 gal. tank on tower, etc. Caldwell Engineering Co., 36 North Side Sq., Jacksonville, is engineer.

Ill., Roxana (mail East Alton)—Roxana Petroleum Corp., Shell Bldg., St. Louis, Mo., plans the construction of an oil pipe line from Roxana to East Chicago and Gary, Ind., a distance of approximately 300 miles including pumping stations every 100 miles. Private plans. Work will be done by owner's forces.

Ind., Gary—Gary Hotel Bldg. Co., 6th St. and Broadway, awarded general contract for the construcion of a 9 story hotel to M. Gerometta. Estimated cost $2,000,000. Steam heating plant will be installed.

Ia., Dubuque—City plans improvements to waterworks including a 4,200 or 5,000 g.p.m. centrifugal pump, 300 ft. head, etc. Burns & McDonnell Engineering Co., 402 Interstate Bldg., Kansas City, Mo., is engineer.

La., Hammond — Weinburger Interests, plan the construction of a 50 ton ice and cold storage plant at South Oak St. and Illinois Central R.R.

La., Lake Charles — Massasoit Mfg. Co., 134 Pocasset St., Fall River, Mass., awarded contract for the construction of first unit to cellulose plant here to P. Olivier & Son, Inc., Lake Charles, La. Estimated cost $200,000. Three other units including boiler plant, etc., will be built later.

Mich., Detroit—J. B. Book, Jr., Book Bldg., had plans prepared for the construction of an 81 story office building including steam heating system, electrically operated mechanical equipment, complete lighting equipment, etc., on Washington Blvd. L. Kamper, Kamper Bldg. Cass Ave., is artchitect.

Mich., Detroit—Dept. of Public Works, City Hall, will receive bids until July 24 for the construction of 2 pumping stations including pump pits, motor driven centrifugal pumps, electrical equpment, etc., one at W. Chicago Blvd. and Mill Rd. and one at Plymouth Rd. and Tremon St. P. A. Fellows, City Hall, is engineer.

Mich., Detroit—Michigan Masonic Home, J. E. Davison, Chn., Bay City, is having plans prepared for the construction of a 2 and 3 story masonic home including detached power house, steam heating boilers, etc., here. Estimated cost $4,000,000. G. W. Graves, 233 John R. St., Detroit, is architect.

Mich., Spring Lake—Village Council, W. D. Specer, Clk., City Hall, will receive bids until Aug. 2 for the construction of a sanitary sewage system including pumping station, etc. Estimated cost $100,000. Pearse, Greeley & Hansen, 6 North Michigan Ave., Chicago, Ill., are engineers.

Minn., Duluth — Hampton Court Apartment Hotel, A. Holstead, 410 Palladio Bldg., will soon award contract for the construction of a 7 story hotel including steam and mechanical ventilating system at East Superior St. and 9th Ave. Estimated cost $1,100,000. Holstead & Sullivan, 410 Palladio Bldg., are architects and engineers.

Neb., Wahoo—Water & Light Comrs., will receive bids until July 19 for one 250 hp. horizontal box header water tube boiler, one under feed force draft stoker, one open feed water heater and one boiler feed pump.

N. Y., Brooklyn—New York Quinine & Chemical Corp., 101 N. 11th St., is having plans prepared for the construction of addition to power plant. Thomas E. Murray Inc., 55 Duane St., New York, is engineer.

N. Y., New York—L. Adler, 557 7th Ave., is having plans prepared for the construction of a 12 story office building at Canal, Varick, Hudson and Watt Sts. Estimated cost $6,000,000. Buchman & Kahn, 49 West 45th St., are architects.

N. Y., New York—Amalgamated Clothing Workers of America, plans the construction of a 5 story apartment at Dickinson and Saxon Sts. Estimated cost $1,500,000. Work will be done by separate contract under the supervision of J. Brodsky, Constr.

N. Y., New York—W. Miller, c/o A. E. Schaefer, 645 E. Tremont Ave., Archt., will build an apartment on Johnson Ave. by day labor. Estimated cost $500,000.

N. Y., New York—M. E. Paterno Corp., 100 East 42nd St., plans the construction of a 13 story apartment at Park Ave. and 72nd St. Estimated cost $2,000,000. R. Candela, 578 Madison Ave., is architect. Work will be done by separate contract under the owner's supervision.

O., Cleveland—St. Lukes Hospital, c/o A. H. Van Gorder, Chn. of Bldg. Committee, 1370 W. 9th St., awarded contract for the construction of a 5 story hospital at E. 116th St. and Shaker Blvd. to Lundoff-Bicknell Co., B. F. Keith Bldg. Estimated cost $2,000,000.

O., Painesville—Lake Erie College for Women, will soon award contract for the construction of a boiler house and laundry. Estimated cost $40,000. A. Garfield, National City Bldg., Cleveland, is architect.

Okla., Greenfield—City is having preliminary plans prepared for the construction of a waterworks system including deep well pumps, etc. Estimated cost $17,000. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Lugert—City, L. L. Smith, Clk., Altus, will receive bids until July 27 for the construction of a dam, softening and filter plant, tank on tower, low lift pumps, etc., on the Red River here. Estimated cost $675,000. Benham Engineering Co., 512 Gumbel Bldg., Kansas City, Mo., is engineer.

Okla., Shawnee—City plans an election soon to vote $75,000 bonds for improvements to waterworks including new well, deep well pumps, etc. F. D. Brown, is engineer.

Pa., Allentown—Light & Power Co. of Allentown, plans the construction of a 12 story office building on Hamilton St. Heimle & Corbett, 132 West 42nd St., New York, N. Y., are architects.

Pa., McKees Rocks—Pressed Steel Car Co., plans the installation of two 1,300 hp. boilers with powdered fuel equipment and a 3,000 kw. turbo generator with auxiliary equipment. Thomas E. Murray Inc., 55 Duane St., New York, N. Y., is engineer.

Pa., Philadelphia—City Mission Home for Consumptives, Chestnut Hill, awarded contract for the construction of a boiler house at 8815 Germantown Ave. to George S. Roth & Son, 230 East Graves Lane.

Pa., Philadelphia — Fairmount Park Comrs., City Hall, will receive bids until Aug. 2 for electric wiring, power, heating and ventilating systems including pumps, motors, etc. Schedule A, B, C, D and E, for Philadelphia Museum of Art Bores, Trembauer & Zantzinger, Land Title Bldg., are architects.

Pa., Philadelphia—Friends Hospital, will soon award contract for the construction of a boiler house at Roosevelt Blvd. and Asylum Pike. A. C. Wood, Stock Exchange Bldg., is architect.

R. I., East Greenwich—Greenwich Mills, Division St., awarded contract for the construction of a 2 story textile mill including boiler house, dye house, etc., to Locke & Thomas Inc. 504 Olympia Bldg., New Bedford, Mass. Estimated cost $40,000.

Tex., Amarillo—C. Berg, H. H. Simpson, 942 Buhl Bldg., Detroit, Mich. and J. W. Brudgington, Amarillo, plan the construction of a steam power plant using gas for fuel here. Estimated cost $1,000,000. Private plans.

Tex., Corpus Christi—City plans an election July 30 to vote $60,000 bonds for extensions and improvements to waterworks including pumping equipment, mains, etc. H. Levinson, is engineer.

Tex., Houston—City, O. F. Holcombe, Mayor, awarded contract for the construction of a pump house at Central water plant to C. W. Ennis, 1402 Marshall St. Estimated cost $150,000.

Tex., San Antonio—J. Freeman, J. Seligman, S. Lang, J. M. Frost and N. Goldsmith, 215 West Laurel St., is having preliminary plans prepared for the construction of a 20-story office building at Houston, Marys and Navarro Sts. Estimated cost $2,000,000.

Tex., San Benito—Sanitary Engineering Co., P. O. Box 1512 Houston, wants quotations, etc., for abbatoir including refrigeration machinery for San Benito.

Tex., Throckmorton—West Texas Utility Co., Cisco, is having plans prepared for the construction of two 75 hp. direct connected power units here. Estimated cost $18,000. E. R. Hoppe, Abilene, is engineer.

Wis., Genesee Depot—H. Greene, 559 Marshall St., Milwaukee, awarded contract for the construction of a dairy to L. Schroeder Construction Co., 13 East 1st St., Fond du Lac. Estimated cost $40,000. Refrigeration machinery will be installed.

Wis., Marinette—Northern Paper Mills, Day St., Green Bay, awarded contract for the construction of two hydro-electric dams at Chalk Hill and White Rapids on the Menominee River near here to Siems, Helmers & Schaffner, 514 Guardian Life Bldg., St. Paul, Minn.

Wis., Menasha—City, J. F. DeCaro, Clk., will receive bids until July 22 for one 600 hp. Diesel engine and two generators for electric light plant.

Ont., Toronto—Cawthra Apartments Ltd., 65 Adelaide St. E., awarded contract for the construction of three 3 story apartment buildings at College and Beverly Sts. to Carswell Construction Co., 57 Wellington St. E. Estimated cost $500,000. Danswell & Dolphin, 61 Adelaide St. E., Archts., will award contracts for electric refrigeration, hot water heating systems, etc.

Que., Montreal—The Weaver Coal Co., Ltd., Longue Pointe, is in the market for a hopper and conveyor system to increase the capacity from 1,500 to 2,000 tons daily, also new crushing plant.